Mining

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THE

# MINING AND SMELTING MAGAZINE:

82087.

A MONTHLY REVIEW OF

## MINING, QUARRYING, AND METALLURGY,

WITH THEIR

ASSOCIATED ARTS AND SCIENCES,

AND

Record of the Mining and Metal Markets.

EDITED BY

HENRY CURWEN SALMON, F.G.S., F.C.S.



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# MINING AND SMELTING MAGAZINE.

JULY, 1863.

## On the Manufacture of Pig-Iron in England.*

BY MM. GRUNER AND LAN.

(Abstracted from the *Annales des Mines*, 5th series, vol. xx, p. 109.)

### I.—GENERAL CONSIDERATIONS.

ACCORDING to Mr. Blackwell, the first attempts to smelt iron-ore with mineral fuel date as far back as the year 1620, but they were not really successful till the year 1740, from which period the use of coke has gradually replaced that of wood-charcoal—a change which was nearly complete about the end of the last century.

This change has taken place in England more rapidly and very much more completely than in France. The abundance of coal in the former country compared with wood has evidently been the primary cause of this; but there are also other causes which are not generally taken sufficiently into consideration in comparing the iron industry of the two countries, and which are due to the different nature of the ores. If the English ores were as pure as the French, there are still at the present day districts in the United Kingdom where smelting by charcoal might be advantageously carried on; for this fuel is neither as rare nor as dear there as is generally supposed. Thus at Pontypool, in Wales, the cost per ton of wood-charcoal, delivered at the forge, does not exceed 50*s*.† But the best English ores, except the spathic irons and certain brown hematites, would not yield, with vegetable fuel, any product at all analogous to the pig-irons of Comté, Périgord, and Berry. With the exceptions of the

* This portion of MM. Gruner and Lan's Memoir *preceded* the descriptions of the various districts in the original. We have, however, thought it more advisable to reverse this arrangement, and give it as a *sequel*.—ED. M. & S. M.

† We are aware that this price would rise rapidly if there were many furnaces worked with charcoal in this district. Still, in the thinly populated counties of Wales and the North of England, wood is tolerably abundant.

spathic irons and the soft mines mentioned, the red hematites of Lancashire and Cumberland are the only English ores suitable for smelting by charcoal; and even they have to be selected with care, for they are frequently very quartzose, and the purest red hematites are not in any respect equal to the French granular tertiary ores. There are still indeed in Lancashire two or three blast-furnaces worked with vegetable fuel.

Hence the rapid disappearance in England of blast-furnaces worked with wood fuel by no means indicates a similar extinction in France, where, on the contrary, there is every reason to presume that the charcoal pig-iron will long be able to compete with pig manufactured with coke—particularly if only ores of a very superior quality are used.

The constant aim of every industry is the continued reduction of the cost-price of its products. Leaving aside the value of the raw materials, the manufacturer of pig-iron is in a position to realise this reduction of cost by four principal means: (1) by reducing the consumption of fuel; (2) by increasing the production of the furnaces; (3) by developing and perfecting the mechanical appliances; and (4) by substituting forge cinders for iron ores, properly so called. Such, in fact, have been the various means to which the English smelters have, from time to time, had recourse; but, although in each case the progress of improvement has been great, the cost-price of the pig-iron is still the same as it was thirty years ago, if indeed it is not higher, in consequence of the gradual increase in the price of the raw materials and of labour. The progress of the smelter in improvement has simply balanced these rises in prices.

Thus in 1825, according to the *Voyages Métallurgiques*, the cost-price of the forge-pig in Wales was 2*l.* 8*s.* 6*d.*, while at present, for *analogous qualities*, it ranges from 2*l.* 15*s.* to 3*l.* 5*s.*, and for inferior pig for rails, from 2*l.* 5*s.* to 2*l.* 10*s.* In Scotland, in 1833, foundry-pig cost 2*l.* 7*s.* 4*d.*, and in 1860, 2*l.* 7*s.* 9*d.* In Staffordshire the cost-price of grey-pig is at present, as it was thirty years ago, about 3*l.* 10*s.* on an average. Consequently, since the causes which tend to raise the prices of the raw materials and of labour are always in action, while the futher improvements in the methods of smelting seem doubtful, we are of opinion that the cost-price of pig-iron in England must continue to increase.

Let us now see in what consist the improvements that have been realised by the English iron-makers during the last thirty-five years.

1. *Economy in Consumption of Fuel.*—The reduction in the consumption of fuel is principally due to the adoption of hot air, and the substitution, in certain districts, of raw coal for coke. Also often, as we shall show, to a simple enlargement of the throat, which, in prolonging the time the ores remain in the furnace, has led to a notable economy in the consumption of fuel.*

* Mr. Truran attributes the economy realised in England during the last thirty years almost entirely to the enlargement of the throat—which is an evident exaggeration.

The greater part of these modifications date from a period extending from 1830 to 1835, and were pointed out in the second edition of the *Voyages Métallurgiques*. Besides these, in certain works a reduction of consumption has been brought about by modifying the working of furnaces. Instead of grey-forge pig-metal it is endeavoured to produce a white granular pig, slightly carburised. This is especially the case in Wales, particularly in those works where a considerable proportion of forge-cinders or very silicious red hematites are used. It may certainly be questioned if such an economy is not purchased too dearly by the depreciation in the quality of the products, for such a class of pig-metal is only fit to be manufactured into very inferior merchant iron and rails—and that with a greater waste than in the case of ordinary grey pig-metal. The reduction of the ores is besides in this case always incomplete, and consequently their produce is less.

Another means of reducing the consumption of fuel—and which has been in use for a long period in France and Germany—is the utilisation of the gases from the blast-furnaces. In this respect the English ironmasters have been for a long time, and are still, behind those of the Continent, as has been admitted by Mr. Blackwell. The first trials of employing furnace gases were only attempted in England in 1845—at the Ystlalyfera works according to Mr. Blackwell, but at the Ebbwvale works according to Mr. Truran: at Ystalyfera they only attempted in the first place to utilise the heat of the gases themselves without admitting the air. At present, however, all the Cleveland furnaces, and half of those in Wales, utilise the gases for heating the blast and the boilers; but this is still the exception in Staffordshire and in Scotland. Several English ironmasters, with Mr. Truran at their head, allege that it is impossible to utilise the gases of a blast-furnace without interfering with its working. This is indeed true where the throats are large, and where the gases pass out at their circumference; but all inconvenience disappears when they are taken from the centre by means of apparatus arranged like those of M. Coingt de Montluçon. From this, as yet incomplete, utilisation of the gases it results that, on an average, more coal is consumed in England per ton of pig-iron than in France. Still the consumption of the English works has been considerably reduced within thirty years.

In Wales, in 1830, the consumption per ton of forge-pig averaged 4 tons of coal; at present, in the works where the gases are utilised, it ranges from 2 tons to 2½ tons. In Staffordshire, in 1830, it was from 6 to 6½ tons for grey pig; at present, with ores of about 40 per cent. it averages 4 tons. In Scotland, before the adoption of raw coal and hot air, it ranged for black foundry-pig from 7½ to 8 tons of coal, calcining and engines included; at present with calcined ores of from 55 to 60 per cent. it is only from 2 tons 8 cwts. to 2 tons 12 cwts. Lastly, in Cleveland, where the gases are well utilised, the consumption in treating calcined ores of 40 per cent. ranges from 2 tons 16 cwts. to 3 tons. In France, on the other hand, in a considerable number of works the consumption does not exceed from 2 tons to 2 tons 4 cwts., where the coals are strongly carbonised and the average produce of the ores is about that of

B 2

Wales, Cleveland, and Staffordshire—that is 40 per cent. (Loire and Creusot). But when the ores are poor, as at Aubin and Decazeville, and the coal slightly carburised, the consumption amounts to as much as 4 or 5 tons.

2. *Increase of Production.*—The average production of blast-furnaces has been more than doubled within the last thirty years, which, of course, has notably reduced the general expenses.

Five and twenty or thirty years ago the blast-furnaces of Wales produced on an average per twenty-four hours from 8 to 9 tons of forge-pig, and those of Staffordshire 7 tons. At present, taking with Mr. Hunt the average of all the works, we find the production to be 20 tons in the first district, and from 12 to 13 tons in the second; but many blast-furnaces produce as much as from 15 to 20 tons in Staffordshire, and from 30 to 40 tons in Wales. We similarly find 19 tons to be the average at Cleveland and 20 tons in Scotland—instead of 7 tons thirty years ago.

This increase is due entirely, as we shall see, to the enlargement of the capacity of the body of the blast-furnaces, for, per cubic yard of capacity, the production is not greater at present than formerly (see table, page 13). The rate of the descent of the charge, and the time taken in reducing and smelting the ores are sensibly the same. This increase of capacity has been brought about by an increase in width rather than in height; for the diameter of the body and the throat have been most modified, and not the height of the body.

Still, in order to force the production of blast-furnaces, it does not suffice merely to increase their capacity—it is also necessary to increase proportionately the volume of blast. Consequently the volume, or the number of the blast-cylinders has been nearly doubled, and even in certain cases at the same time the pressure of the blast has been increased. In certain works, particularly in the Cleveland and Staffordshire districts, in order to admit this double volume of blast, the section of the existing twyers has been simply enlarged; but, as a rule, their number has been increased. Thus in Wales the number has been increased from 2 or 3 to 5 or 7, and in Scotland even to 8 or 10. We shall have to consider the influence of these various modifications.

3. *Improvement in Mechanical Appliances.*—The principal modification introduced in the mechanical appliances used in the working of blast-furnaces has been in the blast-engines. Formerly the only motive power used was the old form of Watt engine—low pressure condensing—the diameter of which was exactly half that of the blast-cylinder. At present the engines used are mostly high pressure, sometimes of Woolf's double cylinder type. Truran even attributes to this alteration alone the enormous saving of one-half or two-thirds of the weight of the coal consumed per cubic foot of blast; but, as we shall see, this saving is equally due to other modifications which took place simultaneously.

High pressure engines are particularly advantageous in readily admitting at any given moment a rapid increase of motive power, and consequently of the pressure and volume of blast. Horizontal blast-engines are but little used in England, but direct-acting vertical engines are sometimes met with.

The lifting apparatus has been generally simplified. When the blast-furnaces are not built on the side of a hill the apparatus most used at present are water-balances, and, particularly in the most modern works like those of Cleveland, pneumatic lifts—which is evidently of all such apparatus the most simple and the least subject to get out of repair.

We may also mention, as an arrangement serving to reduce the accessory expenses attending the smelting of ores, the wrought-iron waggons into which the slag is allowed to flow directly from the furnace, and which are subsequently taken by railway (often by steam power) to the top of high waste-heaps.—The hot air apparatus have been but little modified in England during twenty-five years. In this respect, as in that of the utilisation of the waste gases, the continental ironmasters have nothing to learn from England.

4. *Reduction of the Cinders.*—Another important innovation, which has lead to a considerable reduction in the cost of making pig-iron, is the employment of forge-cinders as an iron ore. These cinders are a rich ore of low value, but their reduction is difficult and always incomplete; besides, they not only whiten the pig-metal, as has been already stated, but they also render it extremely silicious and phosphorised. They cannot therefore be had recourse to, except in the cases of the manufacture of forge pig-metal of an altogether inferior quality. This is the case in the Welsh works, where nearly the whole of the cinders resulting from the refining are almost everywhere resmelted; and it is the same in certain works in Staffordshire where inferior low-priced irons are made. In the greater number of the works of the latter district, however, and in all those of Cleveland and Scotland the use of cinders is exceptional, and when they are fed to the blast-furnace it is always only in a very small proportion. We shall see further on, with respect to the use of cinders, that the economy is more apparent than real. As soon as their proportion becomes at all considerable their reduction remains incomplete—the working of the furnace becomes cold—and almost invariably a moiety of the iron oxides in the cinders pass directly into the slags.

We have thus given a rapid sketch of the position of English blast-furnaces, and we shall now proceed to discuss in detail all that concerns their working. In doing this we shall have to treat successively of:—

The preparation of the fuel and the ores;

The forms and dimensions of the blast-furnaces;

The accessory appliances, such as blast-engines, lifting apparatus, hot air apparatus, gas collectors, &c.;

Lastly, the working, properly so-called, of the furnaces themselves, with a tabular résumé of their production in the various districts.

## II.—Various Operations to which the Fuel, Ores and Fluxes are submitted.

1. *Fuel and Carbonisation.*—The "fat" coals, properly so called, are relatively rare in the iron districts of the United Kingdom. We

have seen that the basins of Central England and Scotland principally contain dry long-flamed coal; and Wales "lean" short-flamed coal. The Newcastle district alone yields caking coal in abundance. Thus in the greater number of the districts the slack cannot be used in making coke: it is necessary to carbonise the large coal, or charge it in its raw state to the blast-furnace.

The use of raw coal, which is the characteristic feature of English blast-furnaces, and which has often been represented as an advantage, is therefore rather an unfortunate necessity. In France the slack can almost everywhere be utilised, while in England, on the contrary, it is obliged to be allowed to collect in waste-heaps, or to be burnt at the surface. It requires the immense riches of England in coal to support such losses.

The two facts, of iron being smelted with raw coal, and of the low price of fuel, have reacted on the methods of carbonisation adopted. In England the necessity of bringing them to perfection has been less felt than in France and Belgium; and in this matter there has been really no progress made in England for twenty-five years. The modes of proceeding described in the *Voyages Métallurgiques* are, for the most part, still in use in England without the least change. In Wales the large coal is carbonised in long rectangular piles; in Staffordshire in conical piles with a central brick chimney. Still all the works whose object is to produce pig-metal and refined irons of the first quality continue to work with coke (Pontypool, Blaenavon, Cyfarthfa, Lowmoor, Lord Ward's works, &c.); and for iron of a medium quality a mixture of coal and coke is very usually adopted.

The objects gained by the carbonisation of the non-caking coals are, consequently, not so much the volatilisation of the gaseous elements of the coal, which generally interfere very little with the working of the blast-furnaces, as the eliminations of the sulphur-pyrites. The process is rather a desulphurisation than a carbonisation, properly so-called, and the making of the coke was originally so named in England. The exclusive use of raw coal for smelting is generally adopted only in Scotland, where, consequently, the pig-metal, at least in part, possesses little tenacity, and the iron is of an inferior quality.

Carbonisation in heaps is equally applied to the mixture of slack and small lumps, but in this case the piles are enclosed between two parallel walls pierced with holes, on the system formerly employed at Creusot and Grand'-Combe. We have seen this method in use at Pontypool and Abersychan, in Wales, and at Shelton, in Staffordshire. The walls are from 7′ to 7½′ high and 9′ apart, the bottom between them is flagged, and in the thickness of the walls, besides the openings for the admission of air, there are vertical chimneys. The large coal is placed at the bottom, stacked so as to leave passages opposite the openings, and on this the slack is heaped up.

At Newcastle, where the coal is generally caking, the large has been for a long period carbonised in vaulted kilns of various sorts (*Voyages Métallurgiques*, I, 254). This system is disappearing since M. Bérard has introduced his washing machine into England. In those districts where the coals are caking the carbonisation of the ·ck is gradually being substituted for that of the large. The

kilns adopted are similar to those of La Loire—that is, some round or rectangular with a single door, and others rectangular or oval with two doors. In the rectangular furnaces the drawing is generally effected by mechanical means as in France. Kilns with outside walls to prevent the escape of the heat have been but little employed up to the present time, and the products of distillation are not collected. In short, the making of coke in England presents no special features, and is behind the improved methods, without admission of air, adopted in France by Appolt and Knab, and in Belgium in the narrow rectangular kilns.

In the English works where part of the coal is made into coke, there is no accurate account kept of its cost. The expenses of carbonisation are mixed up with those of the labour proper of the blast-furnaces, and the fuel consumed always figures as raw coal in the cost-price of the pig-metal. It is generally supposed, however, that the cost of carbonisation ranges from 1*s*. 3*d*. to 1*s*. 6*d*. per ton. As to the proportion of coal consumed, that evidently depends on the amount of volatile matter, and is indeed rarely ascertainable with precision on account of the varying weight of local tons used in weighing the coal delivered. It may be taken for granted, however, that in Wales from 1 ton 10 cwts. to 1 ton 12 cwts. of coal is required per ton of coke, while in Newcastle, and particularly in Staffordshire, where the carbonisation is in the open air, and the coal is dry and long-flamed, the consumption often exceeds 2 tons.

The appearance and character of the coke varies as we know with the nature of the coal. Staffordshire coke is friable, fritted, and badly agglutinated, preserving more or less the schistose form of the fragments of coal: it is a dull-grey, almost black. In Wales, where the coals carbonised are short-flamed semi-bituminous, the agglutination is more advanced, and certain varieties are even well caked and compact: but in general the coke is also more or less schistose and of rather a dark shade. In the north of England, on the contrary, a beautiful silver-white coke is produced, well caked and divided into needles, all the more thread-like as the proportion of volatile matters is greater.

Instead of carbonising the slack it may be *agglomerated*. In France this mode of preparation has taken a great extension, and promises still further to develope itself. The generally caking nature of the French slack, the small proportion of large furnished by the mines, and the extremely different value of the large and of the slack, sufficiently explain the favour which the agglomerating processes enjoy in France. In England the conditions are very different. The small is less abundant, and above all is drier, and the price of the large on the mines is scarcely more than the united cost of the agglomeration and washing of the slack. In France these two operations cost from 6*s*. 6*d*. to 8*s*. 6*d*. per ton agglomerated, and the agglomeration alone costs at least 5*s*. 9*d*. Notwithstanding this, certain works for the agglomeration of slack (called in England patent fuel) have been established at Swansea, where the slack is abundant and especially fitted, on account of its anthracitic character, to yield good products. As in France, the processes vary, but are almost all founded on the employment of pitch. Still, M. Bessemer

in England, like M. Barroulier in France, has recourse to a simple mixture of fat slack with lean slack. The Swansea patent fuel bricks are adopted in the steam navy on account of their high calorific power, and they may possibly likewise be utilised in blast-furnaces instead of large raw coal.

2. *Calcination of the Ores.*—The methods of calcination have, during thirty years, been subject to even less modification than the processes of carbonisation. It is effected by the following methods:—

1. Calcining or burning in clamps;
2. Calcining or burning in kilns.

The first system is only suitable to the coaly carbonates (blackbands); the second system is more uniform and economical, and to a great extent avoids the risk of obtaining semi-fused masses, real cinders in fact, very difficult to reduce.

In England the greater proportion of the ores are calcined—the coal-measure carbonates, the Cleveland ores, the spathic ores, and even frequently the hydrated ores. The only ores in general charged in a raw state are the red hematites of the North of England.

The calcination in clamps is effected in piles, laid entirely open on a bed of coal—a process characteristic of the very infancy of industry. The clamps have the form of truncated rectangular pyramids, from 3′ to 10′ high—the higher limit being only met with in Scotland, and in those districts where, as in that country, they calcine ores containing the fuel in themselves (blackbands). Calcining in clamps is specially characteristic of Scotland and Staffordshire: it is rarely adopted in the Welsh works, but still we have seen it at Yniscedwin, near Swansea.

The cost of calcining, like that of carbonisation, is almost always mixed up with the other expenses of the blast-furnace. It may, however, according to Truran, be taken on an average at 8½*d.* per ton, viz.:—

| | *d.* |
|---|---|
| Labour in stacking, &c. | 4 |
| Coal 2½ cwt., of which 80 per cent. is slack | 4¾ |
| Total | 8¾ |

At Yniscedwin the consumption of fuel, according to the verbal statements of the manager, reached as much as 4 cwts. or 5 cwts. of anthracite per ton of ore.

Calcining in kilns is much more widely adopted than calcining in clamps. It is in use in most of the Welsh works, and in all those of Cleveland. The kilns for the most part, instead of being circular, as in France, have in the interior a rectangular form, with the angles rounded off. This form is evidently more favourable for large kilns than the circular one; the temperature is more even in the various parts, and the descent of the charges takes place throughout under identical conditions.

The interior has sometimes the form of a reversed truncated pyramid, the walls of which have a uniform inclination from the throat to the floor (Dowlais); sometimes that of a vertical prism, with the lower part contracted into a truncated pyramid more or less

curved (Sirhowy). In the greater number of works these calcining kilns are much larger than those described in the *Voyages Métallurgiques*. We see some at Sirhowy which are as much as 35′ or 40′ long, by 10′ wide, and 18′ to 23′ high; although there are others in the same works which have the same height and width but are only 14′ long. These latter will turn out per twenty-four hours as much as 35 tons of calcined ore.

At the Dowlais works the kilns are 20′ long, 10′ wide, and from 13′ to 17′ high. They have all openings in front, from 1′ 8″ to 2′ wide, for the drawing and filling of the ore, occupying the whole length of the furnace, and above which are apertures for regulating the draught. The ironstone is charged without being broken up, and sometimes in large fragments—a practice which Truran himself admits to be blameable. The loss in weight of the argillaceous ironstone on calcining is, on an average, from 25 per cent. to 30 per cent.; that of the blackband reaches as much as 50 per cent.; while the loss on the Cleveland ore is only 25 per cent.

Truran states that a kiln with an interior capacity equal to 70 tons will calcine 20 tons of argillaceous ironstone per twenty-four hours; and he estimates the consumption in small coal at 5 per cent. of the weight of the ore—one-third of the quantity burnt by calcining in the open air. The total cost of calcining in kilns he estimates at $2\frac{3}{4}$*d.*, as follows:—

| | *d.* |
|---|---|
| Labour in filling, &c. .. .. .. .. .. .. | 1 |
| Small coal 1 cwt. (in the Yorkshire works small coke is used) .. | $1\frac{1}{2}$ |
| Interest of capital, maintenance .. .. .. .. .. | $0\frac{1}{4}$ |
| Total .. .. .. .. .. | $2\frac{3}{4}$ |

A furnace capable of calcining 20 tons per twenty-four hours, or 7,300 tons per year, costs about 160*l.* The interest on this at 5. per cent. would be 8*l.*, or about $\frac{1}{4}$*d.* per ton.

3. *Preparation of the Limestone.*—In general the limestone is at most very roughly broken; and on this point, as on many others, we find less care taken in the English works than in those on the Continent.

In some works the limestone is converted into quicklime in large lime-kilns by the side of the blast-furnaces. It has been ascertained, as we shall see, that this causes a slight economy on the quantity of fuel consumed. We have noticed the use of quicklime at Sirhowy and Cyfarthfa works in Wales, and at the Russell works near Dudley.

## III.—Forms and Dimensions of Blast-Furnaces.

1. *Degree of Importance to be attached to these Dimensions.*—The time is passed when an extreme importance was attached to the smallest details in the form of blast-furnace. It is no longer attempted to make a servile copy of such and such a special form that had been found to give satisfactory results in some noted works. It is understood at present that a few degrees more or less in the inclination of the boshes, or a such and such more or less unusual form of the hearth or the body, can have no very great influence on

the working of blast-furnaces. Indeed the authors of the *Voyages Métallurgiques* had already discovered "that the dimensions of furnaces did not require so many changes as might be supposed with the variation of the fuel and of the ores." But the English ironmasters in this respect have perhaps fallen into an opposite extreme. They generally treat the form of their furnaces too cavalierly, if we may use the term; for in some works we often see the most varied forms adopted almost at random, and without any plausible reason.

For if certain dimensions can be modified without inconvenience, there are others which cannot be altered with impunity. Thus in the region of the twyers a temperature capable of smelting the ore is necessarily required, and consequently the dimensions of the hearth must be comprised within certain limits. It is also necessary that the charge should descend with a certain slowness, so as not to reach in too short a time a very high temperature, otherwise the fusion may precede the reduction, or at least the latter will only be effected by a consumption of solid carbon. There is, consequently, a certain relation between the capacity of the body and the volume of the blast, or between the capacity and the production of the furnace. The working of a furnace ceases to be economical when, per ton of pig-iron, the capacity of the body descends below a certain minimum: we shall see what this minimum is in the English furnaces.

Another important element in blast-furnaces is the diameter of the throat. We know that the gaseous products of the furnace have a natural tendency to follow the walls of the body. Now it has been recently shown that the central portion of the charge descends more rapidly than the exterior portion, and that the ore, especially, descends quicker than the fuel.* Thus that part of the charge which is least exposed to the reducing agents is that which remains the longest time in the zone of reduction; and this fault becomes necessarily aggravated as the diameter of the throat is enlarged, particularly if at the same time the gases are extracted by openings made in the walls of the furnace, and the charging is effected by waggons with traps, which lead to a subsidence of the matters charged at the centre, and an accumulation of the large pieces at the circumference. This inconvenience has been felt at various works where the ores are not very reducible in proportion to their fusibility. Thus at Ponzin it was found impossible to enlarge the diameter of the throat from 5′ to 6½′ (the diameter of the belly being 15′), without interfering with the working of the furnace.†

In England, however, the inconvenience of large throats has been less felt than in France, and for two reasons: The coal-measure ores are all calcined and are very reducible; and the furnaces are charged by barrows with almost always very large pieces of ore and coal, which makes the central part of the charge more permeable. Notwithstanding this, however, even Mr. Truran, the great promoter

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* See MM. Wachler and Schultze, Carnall's Journal, vol. iii, and M. Stahlschmidt, vol. v.

† Dr. Parry gives an instance of a blast-furnace in Wales, where the gases were extracted at the circumference, which worked badly with a throat 13′ in diameter, but which acted very well when the throat was reduced to 7½′.

of furnaces with large throats, admits that such furnaces easily get out of order when the gases are extracted at the circumference. This is remedied to a certain point by a special mode of charging, of which we shall speak further on; but the inconveniences cannot entirely be done away with except by having recourse to an apparatus for collecting the gases from the centre, more or less analogous to that which we owe to M. Coingt de Montluçon.

2. *Various Types of Blast-Furnaces.*—Thirty years ago, when the authors of the *Voyages Métallurgiques* visited England, the greater number of the blast-furnaces were built on a single type. It was that of a furnace with boshes and with generally narrow throats. Still there was even then a commencement made, in Wales and in Scotland, in several works, to suppress the hearth, properly so called, and to approach the interior section of the furnace to that of two truncated cones, joined base to base. Certain Welsh blast-furnaces were even at that period provided with large throats—throats of 8′, 10′, or 12′ in diameter.

At present we can distinguish in England two principal types of furnaces: blast-furnaces with a hearth (see *Mining and Smelting Magazine*, vol. i, Plate III, figs. 4 to 9);* and blast-furnaces either boshes or hearth (figs. 1, 2, and 10 to 12). The distinguishing feature between these is the greater or less rapid enlargement of the body above the twyers, or, in other words, of the section of the furnace in the region of fusion. The hearth is preserved when the ores are not very fusible (especially when they are aluminous), and when the pig-metal requires a high temperature for its production. Thus in the Cleveland district, where the ores are refractory, almost all the blast-furnaces have hearths and boshes (figs. 7, 8, 9), whatever may be the nature of the pig-metal in other respects. In Scotland, where they smelt rich, reducible, and fusible ores with hot air, the boshes have been everywhere suppressed, and notwithstanding this a very black metal is obtained. In Wales and Staffordshire, where the lithiodal ores are easy to reduce and to smelt, the ordinary forge-pig is made with hot air, in furnaces that are usually without a hearth (figs. 3 and 10 to 13); while in these same districts and in that of Yorkshire, when it is desired to produce superior grey pig, for foundry or forge, particularly with cold air, recourse is almost always had to blast-furnaces with boshes (fig. 4 to 6 and 15).

As the English coal-measure ores are less fusible than the Scotch blackbands the blast-furnaces without boshes are, for this reason, less frequent in England than in Scotland; and even in the works where the hearth, properly so called, has been suppressed, its absence has been remedied in some degree by placing the belly of the furnace at a great height, as at Dowlais and Ebbwvale (figs. 10, 11, and 13). This is the type of the *Flussofen* of Styria. When we compare the lines of the Welsh furnaces with those of the Scotch district (fig. 1 and 2), we see, besides, that below the belly the latter have a certain curved splay, which renders the region of fusion very large in Scotland, and relatively restricted in the Welsh works.

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* The plate, showing sections of furnaces, referred to all through this article, will be found in vol. i, Plate III, of the Magazine.

Hence it is evident that even in the United Kingdom it would not be possible with impunity to adopt one form in preference to another, without taking into consideration the fusibility of the ores, and the nature of the metal to be produced. In France, with still greater reason,—since the ores in general are not very fusible—it would evidently be quite irrational to adopt, for the lower portions, as large sections as those of the Scotch furnaces. In respect of economical reduction it is not wise to adopt sections with a very high belly. It is more advisable to enlarge the body by lowering the belly, and then narrowing the lower portion by passing gradually, by a double curve, to a hearth, properly so called (fig. 16).

English blast-furnaces differ considerably from each other in respect of height: there are some only 30′, and others as high as 60′. This point has an essential influence on the capacity of the body, and consequently on the maximum production of the furnace, which would therefore seem to be more or less arbitrary. Still the greater the height the greater the pressure of blast required to overcome the resistence to the movement of the gases, particularly when the ores are pulverulent and the fuel friable. It is the nature of the fuel that seems principally to have influenced the height adopted for furnaces in England. The least elevated are those of the anthracite district in the neighbourhood of Swansea: the old furnaces of Yniscedwin were only 30′ high, and the present furnaces at Ystalyfera and Yniscedwin are only from 36′–40′. The friability of the anthracite and its tendency to decrepitate account for this moderate height.

In the centre of England where the coal is dry and long-flamed, the blast-furnaces rarely exceed from 40′ to 45′ in height, and a considerable number are even at present from 35′ to 36′ high. Here the friability of the coke makes it difficult to adopt larger dimensions, at least unless an exceptional pressure of blast is adopted. In Wales the coke is more resisting; but when raw coal is employed it breaks readily and prevents the employment of very high furnaces: the greater number are only 42′ to 46′ high, and the maximum is only 48½′.

The highest blast-furnaces met with are those of the Cleveland district, which are worked with a solid well-agglutinated coke of the Newcastle basin. Here a few modern furnaces are from 50′ to 60′ high, but the greater number are from 40′ to 46′. In Scotland, notwithstanding the use of the raw, long-flamed coal, certain furnaces have a height of from 53′ to 60′, but the ordinary height is from 43′ to 48′. It has not been observed that the working of these exceptionally high furnaces is more economical than those of an ordinary height, and in general it seems more rational, when it is desired to attain a very great production, to increase the diameter of the belly rather than the height of the body. Thus, in Wales, furnaces of from 46′ to 48′ high have a diameter at the belly of as much as 20′.

3. *Relation of the Production of Furnaces to their Capacity.*—We shall now return to the relation between the production and the capacity of furnaces. With this object, we give, in the annexed table, a summary of the dimensions of the principal English blast-furnaces.

| NAME OF WORKS. | Total Height. | Height of Belly. | Height of Hearth or Crucible. (1) | Diameter of Throat. | Diameter of Belly. | Diameter at Level of Twyers. | Capacity of the whole Body. | Production per 24 hours. | Capacity in cubic yards per ton of pig. | Nature of the Pig-metal. | Percentage of the Calcined Ore. | Observations. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ft. | Ft. | Ft. | Ft. | Ft. | Ft. | Cub. yds. | Tons. | Cub.yds. | | | |
| Ordinary Scotch furnaces (fig. 1) ... ... ... | 46—49 | 19½—23 | 3—4½ | 8—9 | 14—18 | 6—7 | 195—210 | 20—21 | 9¾—10½ | Black foundry | 55—60 | (2) |
| Old Scotch furnaces (1833) ... ... ... ... | 39—42½ | 13—16½ | 7½—8 | 8—9 | 11¾—15 | 3—3½ | 110—120 | 9 | 12—13 | Ditto | 45—50 | (3) |
| Blast-furnaces of the high Scotch type (fig. 2) ... | 52—60 | 26—30 | 3½—4 | 10—11 | 13—15 | 8 | 260 | 26 | 10 | Ditto | 48—55 | (4) |
| Furnaces at Bilston (No. 3) ... ... ... Staffordshire, exceptionally large (fig. 3) ... | 46 | 18 | 3½ | 11 | 14¾ | 8 | 230 | 24 | 9½ | Grey forge | 45—48 | (5) |
| Modern Staffordshire furnaces (fig. 4) ... ... | 41—44 | 13—14¾ | 6½—7 | 9—10 | 13—14¾ | 6—6½ | 155—170 | 16—20 | 8½—9 | Ditto | 45—48 | (6) |
| Old Staffordshire furnaces (1840-1850) ... ... | 39—42½ | 13—13¾ | 6½—7 | 5½—6½ | 11½—11¾ | 4½—5 | 90—97 | 10 | 9—9¾ | Ditto | 45—48 | (7) |
| New furnaces of Yniscedwin and Ystalyfera, South Wales (fig. 5) ... ... ... | 36—39½ | 16½—18 | 6½ | 8½—10 | 11¾—13 | 4½—5 | 105—110 | 10—12 | 9—10½ | Grey foundry and forge | 40—45 | (8) |
| Furnaces at Blaenavon (fig. 6) ... ... ... | 49 | 16 | 6 | 8 | 13 | 4½ | 145 | 14—15 | 10 | Ditto, highly tenacious | 36—38 | (9) |
| Blast-furnaces of the Tees-side works, Middlesboro', Cleveland (fig. 7) ... ... ... | 56½ | 33 | 9 | 10 | 16 | 7 | 250—260 | 30 | 8½—8¾ | Bright grey forge | 40 | (10) |
| Another modern furnace at Middlesboro' (fig. 8)... | 50 | 16¼ | 6½ | 8 | 15 | 6½ | 230 | 25—30 | 8½ | Ditto | 40 | |
| Ordinary Middlesboro' furnaces, built from 1850 to 1855 (fig. 9) ... ... ... ... | 39½ | 16½ | 6 | 8¼—10 | 14¾—17 | 4½—6½ | 175—180 | 20—25 | 7¾—8½ | Ditto | 40 | |
| Large furnace at Dowlais (fig. 10) ... ... ... | 48½ | 30 | 2½ | 10 | 20 | 8 | 300—305 | 45—50 | 6½ | White lamellar or granular | 40—42 | (11) |
| Ebbwvale furnaces (fig. 11) ... ... ... ... | 48 | 19½—23 | 3—4½ | 10—10½ | 15¾—18 | 6—7¼ | 210—220 | 25—30 | 8 | White fibrous or granular | 38 | (12) |
| Ordinary furnaces at Dowlais (fig. 12) ... ... | 42—47 | 19½—26 | 2½—3 | 9—10¾ | 14¾—17 | 6¼—7½ | 180—195 | 25 | 7½—8 | Ditto | 40—42 | (13) |
| Blast-furnaces at Victoria, South Wales (fig. 14)... | 44 | 16½ | 4½ | 7¼ | 15½ | 7 | 150—155 | 24 | 6½ | Ditto | 38 | (14) |
| Blast-furnaces at Tredegar ... ... ... ... | 42½ | 14¾ | 6 | 9½ | 15 | 6½ | 155—160 | 20—22 | 8 | Ditto | 37—38 | (15) |
| Blast-furnaces of Sirhowy ... ... ... ... | 43 | 14¼ | 4½ | 8 | 14½ | 7 | 136 | 20—21 | 6½ | Ditto | 38 | (16) |

**Note.—The figures referred to will be found in Plate III, vol. i, *Mining and Smelting Magazine*.**

(1). When the height is less than 4½′ there is no hearth properly so-called.

(2). The ores are very fusible and highly reducible. The working is with raw coal and very hot air, and the gases are not utilised.

(3). Black-band was not exclusively used at this time. Raw coal, hot air, gases not utilised.

(4). Raw coal, very hot air, gases not utilised.

(5). Coal-measure ores; half coal, half coke; hot air; gases not utilised.

(6). Ditto. The proportion of coal and coke variable, some furnaces working with coke alone. A small amount of cinders added.

(7). The greater number work with cold air and coke. Thirty years ago many furnaces were only 30′ to 40′ high, their capacity from 65 to 70 cubic yards, and the production 7 tons per twenty-four hours.

(8). Anthracite and hot air. Gases utilised at Ystalyfera, but not at Yniscedwin.

(9). Working with coke and hot air, and exclusively coal-measure ores. Ditto Pontypool.

(10). Coke, calcined Cleveland ores and hot air. Gases utilised.

(11). Hot air, with mixture of raw coal and coke, and a large addition of cinders. Gases not utilised.

(12). Hot air, and gases utilised. One-third coal and two-thirds coke—15 per cent. to 20 per cent. of cinders.

(13). Hot air, with mixture of raw coal and coke. Several furnaces only fed with coke. Gases not utilised. 25 to 30 per cent. of cinders.

(14). Hot air, with two-thirds coke and one-third coal. Gases utilised. 25 per cent. of cinders.

(15). Hot air, with half raw coal and half coke. 25 to 30 per cent. of cinders.

(16). Hot air, with half coal and half coke, and quicklime. Gases utilised. 15 to 20 per cent. of cinders.

If we go through this table, and at the same time refer to the lines of the furnaces in the plate, we are struck with the small influence which the dimensions have on the *relative* production of the various furnaces. The largest modern furnaces do not make, in proportion to their volume, more pig-metal than the old furnaces. If the make per furnace has more than doubled during twenty-five or thirty years, the volume has been increased in a like proportion: in Scotland from 120 to 260 cubic yards; in Staffordshire from 65 or 70 to 160 cubic yards; and in Wales from 80 or 90 to 180 or 190 cubic yards.

The principal difference, as might be expected, originates from the nature of the metal. When this is grey or black, fit for foundry use, as in Scotland and certain works of Wales and Staffordshire, it is found that, per ton of pig-iron made per twenty-four hours, the interior capacity is from 9 to 10 cubic yards; for the grey forge-pig of Staffordshire, 8½ to 9 cubic yards; for the bright grey, or mottled, forge-pig of Cleveland, 8½ cubic yards; and for the white forge-pig of Wales, from 6½ to 8 cubic yards.*

These figures are by no means exceptional, and are in perfect accordance with the results obtained at continental works. The make of charcoal furnaces is generally in excess of this. As an extreme instance we may quote the *Flussofen* of Styria and Carinthia, the capacity of which is only from 2½ to 4 cubic yards per ton of metal; and the blast-furnaces of Tuscany, which make 1 ton of pig

* When the make is forced, as is sometimes the case at Dowlais, the capacity [illegible] to 5 cubic yards, but the consumption and yield suffer.

per 1½ cubic yards. It is true that in this latter case the production is evidently exaggerated and is only obtained at the expense of a great consumption of fuel. The descent of the charges takes place in four or five hours, and the carbonic acid, derived from the reduction of the ore, reproduces continually oxide of carbon, by its contact with the incandescent charcoal.

4. *Dimensions and Forms of the accessory Parts.*—The form and dimensions of the crucible are extremely variable in English blast-furnaces, as may be seen by casting an eye at Plate VII of Truran. Some are rectangular, others octagonal or circular. The latter form is evidently the most rational; but, when the diameter is great (6′ to 8′), it is essential to make the sides gradually converge towards the tymp.

The management of the twyers depends upon that of the crucible. When the crucible is rectangular, 1, 2, or 3 parallel twyers are placed on each side; when it is round, the various twyers are placed at regular intervals around it, all converging towards the centre, in which case there are sometimes 8 or 10.

The stack in English blast-furnaces varies as much as in France. In the greater number of the modern type the stack is conical or cylindrical, with a quadrangular, octagonal, or circular base, with circular bracings. Wrought-iron mantles are only generally met with in the North of England and Scotland. In the most modern works the stack is often built on columns, so as to facilitate the repair, or even the removal, of the hearth. At Middlesboro' we saw several furnaces in course of construction built on twelve columns, within which the hearth, properly so called, could be constructed entirely independently. In England, as on the Continent, very thick refractory walls have been abandoned. Those of the hearth have now rarely a greater thickness than from 3′ to 4′.

It was long considered in England that the bottom of the crucible of blast-furnaces should necessarily be composed of millstone-grit; and on the Continent, especially in Belgium, it was equally supposed, in a spirit of servile imitation, that this refractory material could not be dispensed with. At present, in the United Kingdom, the millstone-grit has almost everywhere been replaced by brick, which has rendered the erection of blast-furnaces easier and less costly.

(*To be continued.*)

# Abstracts and Reviews.

## SOUTH WALES INSTITUTE OF ENGINEERS.

The quarterly meeting was held at Newport, on Wednesday, May 13th, under the presidency of Mr. Thomas Evans, F.R.S., the president for the present year. There was also a numerous attendance of members. Mr. Alexander Bassett, C.E., was nominated president for the ensuing year, and the vice-presidents and the members of the council were also nominated. After the transaction of the usual formal business, a discussion took place on Mr. Cox's paper, "On the Selection and Treatment of Coal for the Blast Furnace;" and on Mr. Child's paper, "On the Selection of Coals for Smelting Purposes."

Mr. Child's paper laid down three essential propositions in the selection of coals:—First, their freedom from sulphur; secondly, their physical characters, as on these will depend, practically, their calorific power and intensity; and thirdly, the amount and nature of ash they contain. In a chemical point of view the presence of sulphur in the coal materially affected the working of it in the blast furnace. Sulphur existed in coal mainly in two states; in the first in combination with iron, which is mechanically diffused through the coal; and in the second it is combined with carbon, hydrogen, oxygen and nitrogen, forming one of those complex organic bodies, of which organic chemistry furnishes numerous examples. Basic sulphate of iron is also found in coals. The sulphur in the state of bisulphide of iron is the most prejudicial in the blast furnace, as only half of it can be got rid of. Sulphur contained in coal in any other state than as iron pyrites is driven off more or less completely by coking. When raw coal is used, a large quantity of sulphur is removed by the coal as it sinks, being exposed to a gradually rising temperature, and it is virtually coked before reaching the zone of reduction. Sulphur may be eliminated by watering or steaming the coke, or by adding salt to the coke. The latter is known as Calvert's patent, and under certain circumstances it is superior to steam or water. As to the physical characters of the coal to be used, the coals of the eastern part of the South Wales coal-field are of too caking a nature for direct use in the blast-furnace. In proceeding westwards, the coal becomes less bituminous and cakey, and at some of the Merthyr furnaces raw coal alone is used. The unpleasant faculty of decrepitation, when heated rapidly under blast, renders the use of the anthracite difficult, but the anthracite is well adapted for assaying. The remainder of the paper referred to the ashes of coal and coke, and their chemical properties.

Mr. Cox disputed the correctness of the theories in the paper, and held that Mr. Child was quite wrong in his ideas. The appearance of coal was no criterion as to the quantity of sulphur it contained, and practice fully bore out this assertion. Then, as to the mode of elimination, they hardly knew what they were doing under the salt process, as there were no conclusive results to guide them, and he therefore decidedly preferred the steaming process.

Mr. Adams said there was one mistake in the paper. The coals of the eastern crop of the South Wales coal-field had and continued to be used in a raw state in the blast-furnace.

Mr. Richard confirmed Mr. Adams's statement, and remarked that coal with iron pyrites made the best iron after coking.

Mr. Brough and several other gentlemen stated that coal which apparently had a large quantity of sulphur was really found in practice to contain less sulphur than coal which appeared to the human eye quite free from it.

Mr. Brogden said that they had tried the salt process of elimination at Tondu, but they found no difference at the furnace. He fully agreed with Mr. Cox that the appearance of coal was no critèrion as to what sulphur it contained, and that steaming was the best mode of elimination.

Mr. Child replied to the arguments advanced, and a vote of thanks was passed to him and Mr. Cox for their excellent papers.

Mr. Hedley's paper on "The Long-Wall System" came next under discussion. This paper described the long-wall system, and its results in Derbyshire, Nottinghamshire, Leicestershire, and Warwickshire. Before the discussion was proceeded with, Mr. Naysmith's paper on the long-wall, double-stall, and pillar-and-stall modes of working was read.

Mr. Naysmith, sen., expressed his decided approval of the pillar-and-stall, so far as it had come under his notice. Where were they going to have their gob wall, under the long wall, more especially in a district like the Aberdare valley, where the top as it were burst out? He could never believe that they could work the Aberdare coal with profit by long-wall.

The pillar-and-stall had never been fairly tried at Aberdare. In the north of England they had a system at work—the double turn—by which they obtained double the quantity of coal from a given space to what was now the case at Aberdare. Whether they adopted pillar-and-stall or any other mode of working, they would never be able to compete properly with the north of England until they followed the plan referred to.

Mr. John Williams differed with Mr. Naysmith, except as regards the larger seams. They found the long-wall a great advantage, and far superior to the pillar-and-stall. In the 6-feet coal they found that the falls came down on the gobs and formed good supports. They were equally successful in the 4-foot. A greater quantity of coal could be obtained by long-wall, and it was in a better state for the market.

Mr. Wilkinson said he had introduced the long wall (in Mr. Powell's collieries in the Aberdare valley), and they had been working it successfully for some years. There was less gas standing than in the pillar-and-stall, and there were never any complaints now of tender coal.

Mr. Bedlington said he had been of opinion for some time that there was no difficulty in working coal of 6 feet and under by long-wall. All beds of coal did not lie the same, and therefore it was not easy to adopt long work in every place. They were all pillar-and-stall men originally, and therefore it was quite clear that long-wall was superior, or else they would not have taken the trouble to change the system.

After some observations from Mr. Brough, Mr. Naysmith, sen., and other members, a vote of thanks to Mr. Hedley closed the discussion.

Mr. Joseph Hale's paper on "The Ventilation of Mines." This subject was next discussed. The writer carefully reviewed the different gases found in collieries, their chemical properties, and their effects on being brought in contact with fire; also the modes of ventilation, machine or natural (the writer strongly recommended the latter, as it can always be depended upon), and copious examples were given of the dimensions of furnaces, &c.

Mr. Brough said he fully agreed with Mr. Hale, and he had gone through some of the formulas and found them quite correct.

In reply to Mr. Murphy, Mr. Bedlington said that from 8 feet to 9 feet was considered a good size furnace, but the dimensions mainly depended upon the depth of the shaft, and other matters.

The President said he and other gentlemen had tried an experiment at Forchaman Colliery, and they found that a far larger quantity of air passed by closing up the furnace as far as possible, with the exception of the grate.

Mr. George Brown said, if all the blast were brought down as suggested by the Chairman, he did not think they could get any bars to stand. He was an advocate for large returns, but the difficulty was to keep them large. He gave an instance of an air-way at Mountain Ash, which had so contracted in three days that the men were obliged to leave off work in that particular part of the colliery. Another strange matter he had noticed at their colliery was that blowers and falls generally happened between one and five in the morning. Mr. Brown gave further details of his experience at Mountain Ash.

Mr. R. W. Toogood said they had tried a bar in puddling which had been recommended by a friend of theirs from Yorkshire, and they found it highly successful. There was a tube running with the bottom of the bar, or in other words, the bar was tubular at the end, and a continual stream of water was kept going through.

Mr. Brough questioned whether such a bar would suit ventilating furnaces. As regards closing up the furnace with the exception of the bars, he trusted it would not go forth as the collective opinion of the Institute that throttling the air was a good plan.

The President remarked that he would be the last to recommend anything that would lessen the ventilation. He simply mentioned that an experiment had been made in order that they might make further researches. He thought the bar mentioned by Mr. Toogood was of some importance.

## ON THE SEPARATION OF COPPER AND NICKEL.

By P. Dewilde.

(*From the Bulletin de la Société Chimique de Paris.*)

As certain alloys of copper and nickel are coined into money in several countries—more especially in Belgium and Switzerland—a reliable and easy method of separating these two metals would be of some importance. Up to the present time, as is well known, sulphuretted hydrogen has been used for this purpose. This process is, however, defective, as the sulphuret of copper very easily changes into a sulphate, as also that more or less sulphuret of nickel is generally precipitated with the copper. The method used by Dewilde which is based upon the reductibility of the oxide of copper by means of grape sugar, is free from those drawbacks.

About 2 grammes of the assay are dissolved in a mixture of nitric and hydrochloric acids: in order to get rid of the excess of acid, the solution is boiled to dryness, and the remainder is dissolved in about 50 cubic centimetres of water. The liquid is then mixed with 4 grammes of pure double cream of tartar and is gently warmed. After the latter substance is dissolved, an alcoholic solution of caustic potash is gradually added, till the precipitates of the subcarbonates of copper and nickel, that were beginning to show themselves, have disappeared—the liquid at the same time assuming a blue colour. A solution of grape sugar is added when that mixture is cooled down, and the whole is then kept boiling for several minutes. The copper falls as a protoxide, and is easily separated if the operator has taken care not to add the sugar before the solution had properly cooled down; in the opposite case, the precipitate is flakey, and is washed out with some difficulty. After the reaction has ceased the protoxide of copper is filtered off and is determined in the usual manner.

The fluid containing the nickel is boiled down to dryness; the remainder is then heated, and is thoroughly washed in order to get rid of the subcarbonate of potash which is produced. These operations having been repeated, the remainder, the greater part of which consists of oxide of nickel is first dissolved in hydrochloric acid, and is then precipitated by potash. The precipitate is washed as thoroughly as possible, and is then dried, gently heated, and ground up in an agate mortar. It is again thoroughly washed in hot water, till all the potash is got rid of; and the resulting oxide of nickel is at last reduced by hydrogen gas in the platinum crucible.

Mons. Dewilde examined at the Belgium Mint the following alloys according to this method:—

| | Alloy A. | | Alloy B. | | |
|---|---|---|---|---|---|
| | 1. | 2. | 3. | 4. | 5. |
| Copper .. .. .. .. | 74·40 | 74·32 | 74·38 | 74·33 | 74·30 |
| Nickel .. .. .. .. | 25·55 | 25·58 | 25·57 | 25·60 | 25·61 |
| Total .. .. | 99·95 | 99·90 | 99·95 | 99·93 | 99·91 |

Both alloys shewed a trace of silicon, but were free from iron and zinc. By law, the Belgian currency must contain 75·0 parts of copper and 25·0 of nickel.

According to Dewilde's special analyses, scarcely 2 kilogrammes of nickel in the 2 grammes of nickel got precipitated; while a very slight, and scarcely separable trace of copper remained in the solution with the nickel.

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## M. MOISSENET ON THE CORNISH METHODS OF DRAWING STUFF.

*De l'Extraction dans les Mines du Cornwall. Puits inclinés et coudés.* Par M. L. Moissenet, Ingénieur des Mines. Paris: Dunod, Quai des Augustins, No. 49.

(*Continued from page* 358, vol. iii.)

V. Winding Engines.—Among the motive powers used in winding, I shall here confine myself to the steam engine; and without entering into detail I shall merely refer to the principal types of Cornish engines—their power, cost, consumption, and duty.

The vertical double-acting, condensing engine is the type generally adopted; horizontal engines are the exception, but a few are met with in East Cornwall and Devonshire. The main object of the makers being economy of fuel, the engines are costly, and, to those accustomed to colliery engines, rather heavy in appearance.

The drums or cages are either horizontal or vertical. When steam was first introduced, it was adapted to the system of the old horse-whims—so that the older steam-whims have mostly vertical cages, a system which is useful when the drawing is alternately from shafts in different directions. But at present the horizontal-axed cages are those most in use—drums being only used for wire-ropes: sometimes the cages are connected directly with the engine, but more usually by gearing, reducing the speed. In mines where the working is principally on one lode, the cage is arranged so as to be in a line with two or even three shafts, in each of which are single kibbles, which are worked in conjunction as required. A deep and productive shaft absorbs, however, the whole power of an engine, whatever the arrangement may be; and this fact, with the introduction of skips, has lead to a most deplorable arrangement in some instances, where, under the pretext that the old shafts are not sufficiently large, only one line of road is laid down, and is worked singly, without any attempt for working another shaft in conjunction—so that the drawing is with a single skip which has no natural counterbalance in the weight of a second kibble with its chains or ropes. This defect is so enormous that it suffices to point it out; but it may be observed that in all cases where shafts are worked in conjunction there is almost always a defect in this respect. While in a colliery two similar shafts are almost always of the same depth, and may therefore be considered as two compartments of the same shaft, it is very rare for a metallic mine to yield, at the same level, at a given time, an equal weight of work at each shaft. It is necessary, therefore, to draw simultaneously from two different levels—that is to say to drop into the shallower an excess of chain which has to be again drawn up as pure loss—an arrangement which besides leads to a waste of labour in filling.

*Principal Dimensions, and Horsepower.*—As the Cornish rotary engines usually work under the same pressure of 35lbs. to the square inch in the boiler ($2\frac{1}{2}$ atmospheres), it is usual in specifying their power merely to state the diameter of the piston in inches. According to the circumstances of their working some practical rules have been laid down by which their nominal power may be ascertained.

With double-acting engines a velocity of 250′ per minute is assumed for the piston, with an average pressure on the piston of 10lbs. per square inch. The H. P. is deduced from the diameter of the cylinder by the following equation :—

$$\text{H. P.} = \frac{\frac{\pi d^2}{4} \times 10 \times 250}{33000}$$

from which we have compiled the following table, which embraces the sizes mostly in use. The asterisk shows those most commonly met with.

| Diameter. Inches. | H. P. | Diameter. Inches. | H. P. | Diameter. Inches. | H. P. |
|---|---|---|---|---|---|
| 18 .. | .. 19* | 22 .. | .. 29* | 26 .. | .. 40* |
| 19 .. | .. 21 | 23 .. | .. 31 | 30 .. | .. 54 |
| 20 .. | .. 24* | 24 .. | .. 34* | 32 .. | .. 61 |
| 21 .. | .. 26 | 25 .. | .. 37 | | |

In the case of single-acting engines, with cylinders under 30″, a velocity of 220′, and an average pressure of 18lbs., is assumed. With Sim's combined a velocity of 250′ is assumed, but it is not agreed what the pressure should be taken at : Mr. W. Brown estimates it at 7½lbs. per inch on each of the two pistons, but the inventor takes it at 10lbs. for the larger piston, which however amounts to pretty much the same thing. The following table gives a sufficient idea of the winding-engines working on certain mines in 1857 :—

A chronological order is pretty nearly followed in this table : the most recent engine given was made in 1851, and since then the sizes of the cylinders have not been much varied. Hence, from this table, it appears that there is a tendency to increase the power and the length of the stroke, an alteration necessitated by the development of the mines in depth.

Formerly 18″ and 20″ engines were made with a 4′ stroke ; but more recently a considerable number of 24″ and 26″ engines have been made with 6′ stroke, and some are as large as 32″ with 9′ stroke ;* in other words the H.P. has advanced from between 19 and 24 to between 34 and 40, and even to 61. In many of the old mines, which have become enriched in depth, we are struck with the unfortunate inadequacy of the power of the engines, which is rendered still more apparent by the adoption of skips, which are not only heavier than kibbles, but can be wound up with much greater rapidity. A few years ago it was estimated that the average was a 22″ cylinder with a 5′ stroke ; but I think that in 1858 this might be taken at 24″ and 61. In the copper and lead mines large crushers are most advantageously worked by engines of from 24″ to 26″, and in many cases a whim-engine works these and winds alternately. In many mines also at present the whim-engine also works a steam capstan.

Many advantages are gained by lengthening the stroke ; the effect of the expansion is increased, and gearing may be dispensed with in connecting the drums or cages. But these are not the main objects, which has been to facilitate the starting of the engine, while still preserving a proper velocity in the shaft, by being able to give a greater radius to the crank. With beam-engines this radius is not necessarily equal to that of half the stroke, since the beam may be unequal ; but it does not do to push this too far, and to get a radius of from 3′ to 3′ 6″, it is well to have a 6′ or 7′ stroke. With cages, the co-efficient of reduction of velocity is often from $^2$ to $\frac{1}{2}$ ; and is often as low as $\frac{1}{3}$ in the case of the large 14′ drums for wire ropes.

* At Great South Tolgus, near Redruth, a 32″ engine, 9′ stroke, draws a single skip, carrying 17 or 18 cwts., with a 4½″ wire rope : the drum is 12′ in diameter and is connected directly, without gearing, to the axle of the fly-wheel.

## WINDING ENGINES.

| Name of Mine | Engine | Type of Engine. | H. P. | Diameter of Cylinder. | Length of Stroke. | Diameter of Fly Wheel. | Weight of Boiler. | Name of Engineer or Maker, and Date. |
|---|---|---|---|---|---|---|---|---|
| | | | | Inches. | Feet. | Feet. | Tons. | |
| Tincroft .. | Martins .. .. | vertical double | 20 | 18½ | 5 | 13 | 7 | Michell, Perran Co., 1825. |
| | Sump .. .. | vertical single | 27 | 24 | 5 | 13 | 7 | J. West, Harvey and Co., 1832. |
| | North .. .. | vertical double | 24 | 20 | 5 | 16 | 7 | J. West, Perran Co., 1835. |
| Fowey Consols .. | Ray's .. | vertical double | 19 | 18 | 4 | 12 | 7 | W. West, Harvey and Co., 1833. |
| | Pown's .. | | 29 | 22 | 5 | 15 | 7 | 1841. |
| | Davis's .. | | 29 | 22 | 5 | 15 | 7 | 1840. |
| | Trathen's | | 24 | 20 | 4 | 12 | 7 | |
| Par Consols .. | Edgecomb's .. | vertical single | 27 | 24 | 6 | 13 | 8 | W. West, Harvey and Co., 1844. |
| | Meredith's .. | vertical double | 34 | 24 | 6 | 15 | 7 | 1843. |
| | Carthew's .. | Sim's combined | 33 | 13<br>24 | 4½ | 14 | 7 | 1843. |
| Great Polgooth.. | West's .. | vertical double | 29 | 22 | 5 | 14 | 7 | W. West, Hodge, 1847. |
| | Hodge's .. | | | | | | | 1847. |
| | Bell's .. | | | | | | | 1849. |
| Trelawny .. .. .. | | Sim's combined horizontal | 34 | 14<br>24 | 5 | 16 | 7 | W. West, West and Sons, 1848. |
| Devon Consols .. | Josiah .. .. | Sim's combined | 52 | 16<br>30 | 5 | 14 | 8 | W. West, Perran Co., 1845. |
| | Anna-Maria .. | horizontal double | 34 | 24 | 6 | 16 | 9 | Matthews, Nicholls Williams, 1851. |

A simple calculation will show us what should be the pressure per square inch on the piston at starting, omitting friction. At Levant the 24" engine has a piston area of 452 square inches, with a 4′ stroke; hence, taking the radius of the crank at 2′, and the drum at 14′ diameter (velocity reduced ⅓ by gearing), and the weight of 240 fms. of 4½" wire rope, with the skip at about 2½ tons on 5,600 lbs., we have—

$$5{,}600 \times \frac{7}{2} \times \frac{1}{3} = 6{,}531 \text{ lbs.}$$

whose quotient by 452 gives 14·4 lbs. as pressure required per square inch.

If we assume the case of a 24" engine 6′ stroke, with 3′ radius of fly-wheel, 12′ radius of drum, no gearing, depth of shaft 300 feet, with 4½" wire-rope, and skip carrying 12 cwts., we have a load at starting of about 2·9 tons, or 6,496 lbs., and the equation—

$$6{,}496 \times \frac{6}{3} \times \frac{1}{452} = 28 \text{ lbs.}$$

This pressure of 28 lbs. at starting, calculated without taking into account loss of power on friction, could only be obtained with a pressure of 35 lbs. in the boiler, or, in other words, it would be impossible to start the engine; or, admitting it were possible to do so, it could only be effected with a serious injury to the machinery.

If, the other conditions being unaltered, we replace the wire rope by a 6" hemp rope, with a cage of an initial diameter of 2′ 6", the load to be raised is increased to 4 tons; but the pressure on the piston is reduced to 8½ lbs., and the starting becomes easy. With the average thickness of the English ropes besides, the mean velocity attained in the shaft will be almost equal to that obtained with wire rope.

These examples show incidentally the great advantages gained by the use of flat ropes, conical drums for round wire ropes not being yet adopted in Cornwall, it will be easily understood that in the greater number of cases the use of these ropes entails an immense increase of the pressure of the steam and is, besides, very trying to the engine.

Returning to the lengthening of the stroke, I have collected, in the following table, the ratio between the length of the stroke and the diameter of the cylinder in several engines.

| Cylinder. | Stroke. | Ratio of Stroke to Cylinders. |
|---|---|---|
| 18" | 4′ | 2·66 |
| 20" | 3′8"—4′—5′—6′ | 2·2—2·4—3—3·7 |
| 22" | 6′—5′ | 2·72—3·37 |
| 24" | 5′—6′—8′—9′ | 2·5—3—4—4·5 |
| 26" | 6′ | 2·77 |
| 32" | 9′ | 3·37 |

Hence the ratio of stroke to cylinder has increased from 2·5 to 3—3·5, and in some engines to more than 4. From these great differences in the value of the ratio, it will be seen that engineers have no fixed rule in this respect, but settle the matter in each case according to circumstances, or probably according to personal opinions. When (according to my notion), the ratio exceeds 3·5, there is a liability that the various parts of the engine, calculated according to the ordinary formulæ, may be found too slight, so that a considerable and destructive vibration may occur, highly injurious to the engine.

Engineers who have endeavoured to attain a very long stroke, such as 8′ or 9′, have sought to do away with the parallel motion, and to substitute for it fixed vertical guides, arranged under the piston rod (Great Wheal Vor, 1855, and West Seton crushing engine). By this arrangement we get a hybrid between the vertical and the horizontal engine, which seems to

express the dislike—more instinctive than reasonable—of certain Cornish engineers for this latter type. Yet, if it is desired to attain a long stroke, the horizontal system is the only one capable of meeting the accompanying inconveniences.

Under most circumstances in Cornwall it may generally be admitted that an engine of 34 H. P., or of 24" diameter, and from 6' to 7' stroke, is sufficiently powerful: the crank may then have a radius of 3' 6", which will ensure an easy working.

*Cost of the Engines.*—In 1858, Messrs. Harvey and Co., of Hayle, charged for winding engines, complete, with cages, boilers, and all accessories, the following prices:

| | £ |
|---|---|
| 18-inch engine, 9-ton boiler.. .. .. .. .. | 550 |
| 20 „ 9 „ .. .. .. .. .. | 640 |
| 24 „ 10 „ .. .. .. .. .. | 770 |

Of course these prices vary considerably with competition and the prices of iron. In 1855 the foundries charged 20*s.* per cwt. for boilers; in 1857, 21*s.*; in 1858, 19*s*. In finding the cost to the mine, we must, of course add the expenses of buildings and the cost of putting up. Speaking roughly, the cost of a large winding engine, new, may be taken at about £1,000.

*(To be continued.)*

## THE BOARD OF TRADE RETURNS.

The "Accounts relating to Trade and Navigation of the United Kingdom, for the month ended 30th April, 1863, and four months ended 30th April, 1863," have been issued by the Statistical Department, Board of Trade.

IMPORTS.—The quantities and relative increase and decrease of the imports of metals, metallic ores, and mineral products, for the month and four months ended 30th April, have been as follows:—

| | Month ended 30th April. | | | Four Months ended 30th April. | | |
|---|---|---|---|---|---|---|
| | 1862. | 1863. | Increase (+) or Decrease (—). | 1862. | 1863. | Increase (+) or Decrease (—). |
| Brimstone ... ... cwt. | 62,930 | 36,070 | — 26,860 | 274,195 | 279,608 | + 5,413 |
| Copper Ore ... ... tons | 9,639 | 7,812 | — 1,827 | 27,812 | 23,473 | — 4,339 |
| Copper Regulus ... ... „ | 2,384 | 2,472 | + 88 | 10,725 | 8,103 | — 2,622 |
| Copper, unwrought and part wrought ... cwt. | 22,380 | 13,860 | — 8,520 | 84,880 | 62,560 | — 22,320 |
| Iron, in Bars, unwrought tons | 512 | 1,546 | + 1,034 | 1,836 | 3,581 | + 1,745 |
| Steel, unwrought ... „ | 235 | 176 | — 59 | 1,486 | 468 | — 1,018 |
| Lead, Pig and Sheet ... „ | 1,160 | 1,173 | + 13 | 4,865 | 6,913 | + 2,048 |
| Spelter or Zinc ... ... „ | 1,153 | 2,652 | + 1,499 | 2,585 | 6,130 | + 3,545 |
| Tin, in Blocks, Ingots, Bars, or Slabs ... cwt. | 9,340 | 5,277 | — 4,063 | 24,395 | 11,607 | — 12,788 |
| Silver Ore... ... value in £ | 14,633 | 56,073 | + 41,440 | 117,784 | 113,813 | — 3,971 |
| Petroleum ... ...tuns | 1,673 | 7,046 | + 5,373 | 3,390 | 11,806 | + 8,416 |
| Quicksilver ... ... lbs. | — | 112,770 | — | 82,731 | 358,098 | +275,367 |

EXPORTS.—The quantities, declared value, and relative increase and decrease of the exports of metals, minerals, and metallurgical articles of British and Irish produce and manufactures, for the month and four months ended 30th April, have been as follows:—

| | QUANTITIES. | | | | DECLARED VALUE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Month ended 30th April. | | Four Months ended 30th April. | | Month ended 30th April. | | | Four Months ended 30th April. | | |
| | 1862. | 1863. | 1862. | 1863. | 1862. | 1863. | Increase (+) or Decrease (—) | 1862. | 1863. | Increase (+) or Decrease (—) |
| | | | | | £ | £ | £ | £ | £ | £ |
| Alkali: Soda ... ... ... cwt. | 170,574 | 236,104 | 633,008 | 712,930 | 72,615 | 97,997 | + 25,382 | 258,700 | 296,280 | + 37,580 |
| Coal, Cinders, and Culm ... ... tons | 707,011 | 792,531 | 2,415,720 | 2,473,294 | 310,213 | 345,791 | + 35,578 | 1,092,215 | 1,111,327 | + 19,112 |
| Iron, Pig and Puddled ... ... " | 46,286 | 46,259 | 133,953 | 139,918 | 125,238 | 127,188 | + 1,950 | 360,232 | 385,819 | + 25,587 |
| Iron, Bar, Angle, Bolt, and Rod... " | 30,100 | 33,111 | 89,679 | 103,913 | 218,137 | 237,760 | + 19,623 | 637,887 | 765,776 | + 127,889 |
| Iron, Railroad, of all sorts ... " | 33,710 | 40,048 | 98,655 | 124,256 | 226,892 | 280,321 | + 53,429 | 709,422 | 876,527 | + 167,105 |
| Iron Wire, except Telegraphic.... " | 1,044 | 1,927 | 2,673 | 6,814 | 24,193 | 39,206 | + 15,013 | 67,400 | 140,183 | + 72,783 |
| Telegraphic Wire and Apparatus ... } value in £ | — | — | — | — | 3,447 | 8,972 | + 5,525 | 99,331 | 36,475 | — 62,856 |
| Iron, Cast ... ... ... ... tons | 4,936 | 7,645 | 16,574 | 27,109 | 43,728 | 63,274 | + 19,546 | 157,542 | 230,105 | + 72,563 |
| Iron Hoops, Sheets, and Boiler Plates ... ... ... } " | 8,707 | 13,401 | 25,507 | 39,503 | 85,648 | 154,187 | + 68,539 | 251,804 | 441,275 | + 189,471 |
| Iron, wrought, of all sorts ... " | 8,688 | 12,738 | 27,622 | 33,021 | 163,262 | 220,001 | + 56,739 | 564,197 | 616,896 | + 52,699 |
| Iron, old, for re-manufacture ... " | 1,793 | 2,638 | 4,445 | 7,018 | 7,549 | 9,264 | + 1,715 | 17,258 | 24,628 | + 7,370 |
| Iron Steel, unwrought ... ... " | 2,349 | 2,461 | 7,633 | 8,523 | 80,109 | 81,489 | + 1,380 | 258,294 | 267,957 | + 9,663 |
| Copper, unwrought, in Ingots, Cakes, or Slabs ... ... } cwt. | 12,191 | 32,156 | 33,263 | 77,023 | 60,657 | 144,187 | + 83,530 | 166,816 | 352,322 | + 185,506 |
| Copper, wrought or partly wrought, Bars, Rods, Bottoms, Pans, Plates, Sheets, and Nails; and mixed or Yellow Metal for Sheathing .. } " | 39,978 | 60,480 | 122,279 | 165,515 | 185,402 | 276,291 | + 90,889 | 589,303 | 758,554 | + 169,251 |
| Copper, wrought, of other sorts... " | 1,103 | 583 | 7,614 | 3,025 | 7,221 | 3,685 | — 3,536 | 49,358 | 18,289 | — 31,069 |
| Brass of all sorts ... ... " | 2,988 | 3,650 | 10,863 | 12,288 | 15,695 | 18,211 | + 2,516 | 59,857 | 60,819 | + 962 |
| Lead, Pig, Rolled, Sheet, Piping, Tubing, and Lead Shot } tons | 2,946 | 3,048 | 7,732 | 11,779 | 61,693 | 64,966 | + 3,273 | 166,577 | 256,031 | + 89,454 |
| Lead Ore, Lead, Red and White, and Litharge of Lead ... } " | 807 | 906 | 2,745 | 2,116 | 17,341 | 21,544 | + 4,203 | 61,545 | 50,281 | — 11,264 |
| Salt ... ... ... ... ... " | 57,968 | 76,222 | 173,388 | 191,620 | 25,593 | 33,330 | + 7,737 | 82,946 | 85,182 | + 2,236 |
| Tin, unwrought ... ... ... cwt. | 4,717 | 7,147 | 22,411 | 22,971 | 28,031 | 43,229 | + 15,198 | 133,887 | 134,297 | + 410 |
| Tin Plates ... ... ... ... " | 78,459 | 135,180 | 338,002 | 374,621 | 93,305 | 156,347 | + 63,042 | 399,628 | 435,949 | + 36,321 |
| Zinc or Spelter, wrought or unwrought ... ... ... } " | 12,268 | 7,600 | 39,101 | 27,325 | 13,101 | 7,091 | — 6,010 | 38,079 | 27,000 | — 11,079 |
| | | | | £ | 1,869,070 | 2,434,331 | + 565,261 | 6,222,278 | 7,871,972 | +1,149,694 |

## M. MOISSENET ON THE CORRELATION BETWEEN THE DIRECTION OF METALLIFEROUS VEINS AND THEIR PRODUCTIVENESS.

*Etudes sur les Filons du Cornouailles et du Devonshire.—Transport des cercles du Réseau pentagonal au point* $a^{\text{iv}}$; *directions utiles pour étain, cuivre ou plomb;* par M. L. Moissenet, ingénieur des mines. *Annales des Mines*, 6th Series, vol. iii, p. 161.

In our number for January last (vol iii, p. 20), we noticed the abstract of M. Moissenet's memoir, given in the *Comptes Rendus*, on the correlation between the direction of metalliferous veins and their productiveness. On that occasion, while we fully recognised the importance of inquiries of the kind, we were compelled to differ from M. Moissenet in the very sweeping conclusions he arrived at. We pointed out that M. Elie de Beaumont's theory of the simultaneous elevation of parallel mountain chains—which is alone capable of affording a rational explanation of the hypothesis—was not received by English geologists, and was indeed repugnant to those principles of geology now most generally received. Admitting that there may be some relation between the origin, and consequently the bearing and production of metalliferous veins, and that of certain mountain chains, we denied that this relation could ever be more than a local one; and expressed our conviction that, in his zeal, M. Moissenet had advanced propositions which he would certainly not be able to establish.

We have little more to add on the present memoir. It is fuller, on some points, than the abstract given in the *Comptes Rendus*, and the author seems to promise us further communications on the subject. In stating, in a note, the position of the point $a^{\text{iv}}$, whose long. W. was given as 80° 10′ 17″, we stated it to correspond with a point in the centre of Cornwall, which was an obvious mistake: its real position is at sea, about 21′ North and 3½′ West of the Land's End.

The following table shows the angular limits of the bearing of the various productive veins according to M. Moissenet's hypothesis, and the relation of the limits to 180°:—

| Nature of Ore. | Bearings. | | Angle. | Ratio. | Ratio to 180°. | |
|---|---|---|---|---|---|---|
| | Magnetic. | True. | $a$ | $\frac{a}{180}$ | Useful. | Not Useful. |
| Profitable tin veins .. | E 30 N to 30 S | E 54 N to 6 S | 60° | $\frac{1}{3}$ | 1 | 2 |
| Profitable copper .. | E 10 N to 50 S | E 34 N to 26 S | 60° | $\frac{1}{3}$ | 1 | 2 |
| Copper abundant .. | E 5 N to 25 S | E 29 N to 1 S | 30° | $\frac{1}{6}$ | — | — |
| Copper rich, but not abundant .. | E 25 S to 50 S | E 1 S to 26 S | 25° | $\frac{5}{36}$ | — | — |
| Profitable lead veins.. | N 10 W to about 40 E | N 34 W to about 16 E | 50° | $\frac{5}{18}$ | 5 | 13 |
| Useful angular limits for:— | | | | | | |
| Tin or copper .. .. .. .. | | | 80° | — | 4 | 5 |
| Copper or lead .. .. .. .. | | | 110° | — | 11 | 17 |
| Tin, copper, or lead .. .. .. | | | 130° | — | 13 | 5 |

# ON THE MINES, MINERALS, AND MINERS OF THE UNITED KINGDOM.

By Robert Hunt, F.R.S., Keeper of Mining Records, Royal School of Mines.

(Read before the Society of Arts, December 17, 1862.)

(*Continued from page* 161.)

It is not possible for us to follow Mr. Wallace in his clear statement of facts, or to give his reasonings, generally marked by great logical discrimination. Suffice it that we state—and this is enough for our purpose—the general bearings of the views put forth by this industrious and cautious observer. After a most painstaking examination of the contour of the country, and the direction of the water shed, not only at the present time, but as it probably existed during the epoch when the veins were forming, Mr. Wallace deduces his "laws of hydrous agency." It is shown that the accumulation of lead ore in the veins is directly connected with the facilities which were offered by the fissures for the flow of water through them; this water—if we read our author right—being atmospheric, and not, as Werner and some others suppose, oceanic. This water, falling on the surface, charged with oxygen and carbonic acid, is supposed by this hypothesis to derive its mineral matter from the rocks through which it penetrates, and that, subsequently, flowing through the cracks in the rocks—this is deposited as "vein-matter," against the sides, or, as they are called, the "walls of the lode."

Quoting Coleridge, who observes that "the metal, at its height of being, seems a mute prophecy of the coming vegetation, into a mimic semblance of which it crystallizes," the author sums up his evidence and makes his deductions. We have followed Mr. Wallace with the most thoughtful attention, and we believe that we shall express the strong features of his hypothesis most clearly by putting it in the following form:—

If it is possible to determine, with any approach to accuracy, the laws which regulated the flow of water through the fissures of any set of rocks, it is possible to predict before working any mineral lode—regarding it as a fissure filled in—whether it is likely to contain metalliferous matter or otherwise, the deposits of metallic ores being dependent on the intensity of force exerted by the aqueous agent, or, in simple language, by the quantity of water flowing through the fissure.

An important addition has been made to our knowledge in the publication, by Mr. Lonsdale Bradley, of Richmond, Yorkshire, of "an inquiry into the deposition of lead ore in the mineral veins of Swaledale."* There is nothing theoretical in this work. A series of sections are given, with sufficient explanations, showing with accuracy the conditions under which a metalliferous condition prevails in the mines of Swaledale.

Mineral veins are either fissures—vast rents—produced by disturbances in the outer crust of the earth, which have been, during the lapse of ages, filled in with matters of various kinds, much of it being metalliferous, or they have resulted from the aggregation of like particles of matter,—which were previously disseminated—during the gradual consolidation of the rocks, forming, at first, slight strings, thin bands, or small concretions. These have given rise to the exercise of crystallogenic force, and thus produced space for the formation of larger deposits.

The last hypothesis considers the mineral veins and the rocks enclosing them to be contemporaneous. The first supposes the rocks to be older than the lodes running through them.

I have rapidly sketched the conditions which exist, at the present time in relation to the mining operations in this country, in especial relation to the amount of knowledge which has been brought to bear on this important subject. I have endeavoured to direct attention to the fact that during

* Published by Stanford, Charing-cross.

a long period of time no advance has been made in our knowledge of the phenomena of mineral deposits; to show how purely speculative have been nearly all the explanations which have been published, in fact, to insist upon the position that empirical knowledge only has been brought to bear on a subject which materially connects itself with the prosperity of the land. I have approached this subject in the most entire independence; I am unbiased by any interest; my desire is purely and simply to aid in the introduction of some system which shall remove mining from that realm of speculation in which it has been suffered to remain.

It is important, in the next place, ere proceeding, to examine the question, can anything be done?—to see if the value of the product is deserving that attention which is necessary to ensure a more satisfactory result. By the continuous labour of some years I have succeeded in securing for this great mining country a statistical record of our mineral produce, which is not excelled by that of any country in the world. The results for the last two* years are shown in the following tables:—

COAL.

Number of Collieries and Quantities and Total value of Coals raised in each County in England, Wales, Scotland, and Ireland, in each of the Years 1860, 1861.

| Counties. | Number of Collieries. 1860. | Number of Collieries. 1861. | Quantities of Coal raised. 1860. | Quantities of Coal raised. 1861. |
|---|---|---|---|---|
| ENGLAND. | | | Tons. | Tons. |
| Northumberland and Durham.. .. | 283 | 271 | 18,244,708 | 19,144,965 |
| Cumberland .. .. | 28 | 28 | 1,171,052 | 1,255,644 |
| York .. .. .. | 387 | 397 | 9,284,000 | 9,374,600 |
| Derby .. .. .. | 153 | 158 | 4,940,000 | 5,116,319 |
| Nottingham .. .. | 21 | 22 | | |
| Leicester .. .. .. | 14 | 11 | 730,000 | 740,000 |
| Warwick .. .. .. | 17 | 16 | 545,000 | 647,000 |
| Stafford and Worcester .. | 568 | 580 | 7,648,300 | 7,253,750 |
| Lancashire .. .. | 371 | 373 | 11,350,000 | 12,195,500 |
| Cheshire .. .. .. | 35 | 39 | 750,500 | 801,570 |
| Shropshire.. .. .. | 68 | 66 | 850,500 | 829,750 |
| Gloucester .. .. | 63 | 71 | 5,503,400 | 6,511,025 |
| Somerset .. .. .. | 37 | 40 | | |
| Devon .. .. .. | 2 | 2 | | |
| Total .. .. | 2,047 | 2,074 | 61,017,460 | 63,870,123 |
| Wales, North .. .. | 84 | 78 | 1,750,500 | 1,870,250 |
| ,, South .. .. | 378 | 403 | 6,254,813 | 6,690,771 |
| Total .. .. | 462 | 481 | 8,005,313 | 8,561,021 |
| Scotland .. .. .. | 427 | 424 | 10,900,500 | 11,081,000 |
| Ireland .. .. .. | 73 | 73 | 119,425 | 123,070 |
| Total for United Kingdom .. .. | 3,009 | 3,052 | 80,042,698 | 83,635,214 |
| | | | Estimated Value. | |
| | — | — | £ 20,010,674 | £ 20,908,803 |

* Mr. Hunt gives an abstract of three years' statistics, but want of space obliges us to omit 1859 in some of the tables.—ED.

## COPPER.

**Number of Copper Mines, and Quantities and Total Value of Ore in each County of England, Wales, and Ireland, and of Fine Copper produced therefrom in each of the Years 1860 and 1861.**

| Counties, &c. | No. of Mines. | | Copper Ore. | | Fine Copper. | |
|---|---|---|---|---|---|---|
| | 1860. | 1861. | 1860. | 1861. | 1860. | 1861. |
| ENGLAND AND WALES. | | | Tons. | Tons. | Tons. | Tons. |
| Cornwall .. .. | 96 | 97 } | 182,534 | 181,594 | 12,210 | 11,663 |
| Devon .. .. | 20 | 20 } | | | | |
| Cumberland and Lancashire.. | 6 | 7 | 2,628 | 2,331 | 184 | 168 |
| Anglesea .. .. | 2 | 3 | 7,713 | 8,792 | 416 | 486 |
| Caernarvon .. .. | 3 | 5 | 2,623 | 2,079 | 114 | 109 |
| Cardigan .. .. | 5 | 2 | 75 | 67 | 5 | 5 |
| Montgomery.. .. | — | 1 | — | 115 | — | 8 |
| Isle of Man .. .. | 4 | 3 | 753 | 1,485 | 53 | 93 |
| Cheshire .. .. | 1 | 1 | 227 | 335 | 155 | 215 |
| Total for England and Wales.. | 137 | 139 | 196,553 | 196,798 | 13,137 | 12,747 |
| | | | Estimated Value. | | | |
| | — | — | £ 1,259,660 | £ 1,118,810 | £ 1,414,745 | £ 1,307,842 |
| | | | Quantities. | | | |
| IRELAND. | | | Tons. | Tons. | Tons. | Tons. |
| Cork .. .. .. | 3 | 4 | 6,466 | 7,350 | 651 | 780 |
| Tipperary .. .. | — | — | — | — | — | — |
| Waterford .. .. | 1 | 1 | 7,765 | 6,670 | 756 | 667 |
| Wicklow* .. .. | 6 | 3 | 4,180 | 1,641 | 586 | 27 |
| Clare .. .. .. | — | — | — | — | — | — |
| Total for Ireland .. | 10 | 8 | 18,411 | 15,661 | 1,993 | 1,474 |
| | | | Estimated Value. | | | |
| | — | — | £ 167,540 | £ 141,263 | £ 206,564 | £ 151,232 |
| | | | Quantities. | | | |
| Copper ore purchased by private contract from sundry districts not included above .. | 23 | 20 | Tons. 21,732 | Tons. 19,028† | Tons. 838 | Tons. 1,110 |
| | | | Estimated Value. | | | |
| | — | — | £ 79,983 | £ 104,654 | £ 84,952 | £ 113,406 |
| | | | Total Quantities. | | | |
| Total for England, Wales, and Ireland .. | 170 | 167 | Tons. 236,696 | Tons. 231,487 | Tons. 15,968 | Tons. 15,331 |
| | | | Total Estimated Value. | | | |
| | — | — | £ 1,507,183 | £ 1,364,727 | £ 1,706,261 | £ 1,572,480 |

* In addition to these copper ores, some copper is separated from the iron pyrites of Wicklow.
† Including some iron pyrites from which copper is separated.

LEAD.—Number of Lead Mines (selling ore), Quantities and Total Value of Ore raised, and of Metallic Lead produced therefrom in England, Wales, Scotland, and Ireland, in each of the Years 1860 and 1861.

| Counties. | No. of Mines. 1860. | No. of Mines. 1861. | Lead Ore 1860. | Lead Ore 1861. | Lead. 1860. | Lead. 1861. |
|---|---|---|---|---|---|---|
| | | | Tons. | Tons. | Tons. | Tons. |
| ENGLAND. | | | | | | |
| Cornwall .. .. | 38 | 44 | 6,401 | 6,690 | 4,242 | 4,229 |
| Devon .. .. | 16 | 11 | 3,019 | 2,762 | 2,030 | 1,791 |
| Cumberland .. .. | 84 | 79 | 7,041 | 6,324 | 5,130 | 4,614 |
| Durham and Northumberland | 39 | 39 | 20,200 | 19,536 | 15,186 | 15,252 |
| Westmoreland .. | 6 | 6 | 362 | 2,392 | 270 | 1,576 |
| Cheshire .. .. | 1 | 1 | 7 | 106 | 3 | 25 |
| Derby* .. .. | — | — | 6,710 | 7,376 | 4,564 | 5,178 |
| Shropshire .. .. | 4 | 9 | 4,032 | 4,616 | 3,161 | 3,547 |
| York .. .. .. | 22 | 30 | 10,665 | 8,801 | 7,099 | 6,203 |
| Somerset .. .. | 4 | 4 | 800 | 860 | 357 | 330 |
| Stafford .. .. | 1 | 1 | 115 | 40 | 75 | 25 |
| Total for England .. | 215 | 224 | 59,352 | 59,503 | 42,117 | 42,770 |
| WALES. | | | | | | |
| Cardigan .. .. | 39 | 43 | 7,355 | 7,755 | 4,952 | 5,886 |
| Carmarthen .. .. | 3 | 3 | 781 | 1,442 | 575 | 1,000 |
| Denbigh .. .. | 14 | 14 | 6,182 | 7,647 | 4,714 | 5,498 |
| Flint .. .. .. | 26 | 48 | 4,947 | 4,410 | 3,767 | 3,396 |
| Montgomery .. .. | 17 | 14 | 2,136 | 2,452 | 1,592 | 1,830 |
| Merioneth .. .. | 5 | 3 | 263 | 207 | 200 | 155 |
| Pembroke .. .. | 1 | 1 | 230 | 97 | 158 | 52 |
| Radnor .. .. | 2 | 2 | 50 | 37 | 35 | 23 |
| Caernarvon .. .. | 18 | 19 | 233 | 172 | 166 | 124 |
| Total for Wales .. | 145 | 147 | 22,177 | 24,219 | 16,159 | 17,964 |
| ISLE OF MAN .. .. | 5 | 5 | 2,810 | 2,717 | 2,091 | 2,043 |
| SCOTLAND. | | | | | | |
| Ayre .. .. .. | — | 1 | — | 1 | — | ¼ |
| Argyle .. .. | 1 | 1 | 21 | 39 | 16 | 29 |
| Kirkcudbright .. | 2 | 2 | 69 | 115 | 48 | 84 |
| Lanark .. .. | 1 | 1 | 1,053 | 742 | 737 | 520 |
| Dumfries .. .. | 1 | 1 | 750 | 803 | 500 | 552 |
| Perth .. .. | 1 | 1 | 80 | 60 | 57 | 43 |
| Total for Scotland .. | 6 | 7 | 1,973 | 1,760 | 1,358 | 1,228 |
| IRELAND. | | | | | | |
| Louth .. .. | — | — | — | — | — | — |
| Armagh .. .. | 1 | 1 | 60 | 45 | 35 | 29 |
| Clare .. .. .. | 1 | — | 95 | — | 64 | — |
| Cork .. .. .. | — | 1 | — | 280 | — | 221 |
| Down .. .. | 1 | — | 168 | — | 128 | — |
| Wicklow .. .. | 2 | 2 | 1,928 | 1,926 | 1,230 | 1,232 |
| Monaghan .. .. | — | 1 | — | 100 | — | 70 |
| Waterford .. .. | 3 | 2 | 130 | 52 | 98 | 40 |
| Galway .. .. | 1 | — | 11 | — | 7 | — |
| Total for Ireland .. | 9 | 7 | 2,392 | 2,403 | 1,562 | 1,592 |
| SUNDRIES .. .. | — | — | 40 | 55 | 30 | 37 |
| Total for United Kingdom .. | 380 | 390 | 88,744 | 90,657 | 63,317 | 65,634 |
| | | | Estimated Value. | | | |
| | | | £ 1,232,063 | £ 1,136,249 | £ 1,412,760 | £ 1,445,255 |

* The number of mines in Derbyshire is not known, but the ore is generally obtainable from small workings, producing only a few cwts. to two or three tons per annum.

## IRON ORE.

**Quantities and Total Value of Iron Ore raised in each county of England and Wales, and in Scotland and Ireland, in each of the years 1859, 1860, and 1861.**

| Counties. | 1859. | 1860. | 1861. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| ENGLAND AND WALES. | | | |
| Northumberland and Durham .. | 13,320 | 12,500 | 10,750 |
| Cumberland .. .. .. .. | 403,177 | 468,782 | 472,195 |
| Lancashire .. .. .. .. | 445,046 | 520,829 | 519,180 |
| York, West Riding .. .. .. | 175,000 | 255,700 | 235,500 |
| „ North „ .. .. .. | 1,520,342 | 1,471,319 | 1,130,761 |
| Derby .. .. .. .. .. | 325,500 | 375,500 | 396,520 |
| Stafford .. .. .. .. | 1,449,000 | 1,523,929 | 1,226,695 |
| Oxford.. .. .. .. .. | 6,033 | 5,833 | 5,600 |
| Buckingham and Northampton .. | 130,058 | 95,664 | 113,139 |
| Lincoln .. .. .. .. | 2,000 | 16,892 | 33,559 |
| Warwick .. .. .. .. | 30,500 | 19,500 | 15,250 |
| Shropshire .. .. .. .. | 197,589 | 165,500 | 223,400 |
| Flint, &c. .. .. .. .. | 87,072 | 85,097 | 86,500 |
| South Wales .. .. .. .. | 649,758 | 630,705 | 545,706 |
| Gloucester .. .. .. .. | 106,292 | 90,466 | 100,420 |
| Somerset .. .. .. .. | 29,083 | 24,102 | 32,763 |
| Wilts .. .. .. .. .. | 28,993 | 76,201 | 55,779 |
| Hants .. .. .. .. .. | 9,725 | 6,119 | 4,008 |
| Devon .. .. .. .. .. | 3,598 | 3,836 | 5,399 |
| Cornwall .. .. .. .. | 35,213 | 23,953 | 26,262 |
| Total for England & Wales . | 5,647,299 | 5,872,427 | 5,239,386 |
| Isle of Man .. .. .. .. | 1,282 | 1,671 | 967 |
| Scotland .. .. .. .. | 2,225,000 | 2,150,000 | 1,975,000 |
| Ireland .. .. .. .. | 3,000 | 106 | 165 |
| Total for United Kingdom.. | 7,876,581 | 8,024,204 | 7,215,518 |
| | Total Estimated Value.* | | |
| | £ | £ | £ |
| | 2,507,860 | 2,466,929 | 2,302,371 |

* The estimated value at the place of production.

## TIN.

**Number of Mines, Quantity of Ore raised, and White Tin produced therefrom, in England, in each of the Years (ending 29th September) 1860 and 1861.**

| Counties. | No. of Mines. | | Tin Ore. | | White Tin. | |
|---|---|---|---|---|---|---|
| | 1860. | 1861. | 1860. | 1861. | 1860. | 1861. |
| | | | Tons. | Tons. | Tons. | Tons. |
| Cornwall .. .. | 139 | 144 | 10,225 | 10,725 | 6,656 | 7,016 |
| Devon .. .. | 4 | 4 | 175 | 238 | | |
| | 143 | 148 | 10,400 | 10,963 | 6,656 | 7,016 |
| | | | Estimated Value. | | | |
| Total .. .. | — | — | £ 812,160 | £ 793,698 | £ 866,306 | £ 857,706 |

## PIG IRON.

**Quantities and Total Value of Pig Iron made in each county in England, Wales, and Scotland, in each of the Years 1859, 1860, and 1861.**

| Counties. | Quantities. 1859. | 1860. | 1861. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| ENGLAND AND WALES. | | | |
| Northumberland .. .. .. | 31,500 | 69,093 | 73,260 |
| Durham .. .. .. .. | 370,339 | 340,921 | 312,030 |
| Cumberland .. .. .. } | 76,588 | 87,950 | 55,165 |
| Lancashire .. .. .. } | | 81,250 | 109,377 |
| York .. .. .. .. .. | 301,077 | 346,765 | 377,521 |
| Derby .. .. .. .. .. | 139,250 | 125,850 | 129,715 |
| Stafford and Worcester .. .. | 616,800 | 616,450 | 583,350 |
| Shropshire .. .. .. .. | 149,480 | 145,200 | 140,791 |
| Flint, &c. .. .. .. .. | 26,980 | 49,360 | 46,658 |
| South Wales .. .. .. .. | 985,290 | 969,025 | 886,300 |
| Somerset .. .. .. } | 10,500 | 1,960 | 17,330 |
| Wilts .. .. .. .. } | | 21,865 | |
| Gloucester .. .. .. .. | 31,750 | 26,458 | 23,163 |
| Northampton .. .. .. .. | 12,800 | 7,595 | 7,730 |
| Total for England and Wales | 2,752,354 | 2,889,752 | 2,762,390 |
| Scotland .. .. .. | 960,550 | 937,000 | 950,000 |
| Total for United Kingdom.. | 3,712,904 | 3,826,752 | 3,712,390 |
| | Estimated Value. | | |
| | £ 11,138,712 | £ 11,480,256 | £ 9,280,975 |

## ZINC.

**Number of Mines in Great Britain, Ireland, and the Isle of Man. Quantity of Ore and Metallic Zinc produced therefrom in each of the Years 1859, 1860, and 1861.**

| Counties, &c. | Number of Mines. 1859. | 1860. | 1861. | Zinc Ores. 1859. | 1860. | 1861. |
|---|---|---|---|---|---|---|
| | | | | Tons. | Tons. | Tons. |
| Cornwall .. .. .. | 18 | 19 | 6 | 2,423 | 4,772 | 5,694 |
| Devon .. .. .. | 2 | 3 | 1 | 289 | 217 | 51 |
| Derby .. .. .. | * | * | * | 1,500 | 1,470 | 1,225 |
| Shropshire .. .. .. | 1 | — | — | 66 | — | — |
| Cumberland .. .. .. | 3 | 3 | 3 | 660 | 558 | 597 |
| Cardigan .. .. .. | 7 | 8 | 8 | 2,436 | 2,230 | 1,807 |
| North Wales .. .. | 8 | 8 | 8 | 3,089 | 2,543 | 2,250 |
| Isle of Man .. .. .. | 1 | 1 | 1 | 2,564 | 3,181 | 3,255 |
| Ireland .. .. .. | 2 | 2 | 2 | 77 | 580 | 890 |
| | 42 | 44 | 29 | 13,104 | 15,551 | 15,769 |
| | | | | Metallic Zinc. | | |
| Total produce of the United Kingdom | | | | Tons. 3,697 | Tons. 4,357 | Tons. 4,415 |
| | | | | Estimated Value. | | |
| | | | | £ 75,782 | £ 89,536 | £ 79,101 |

* The number of mines is not known.

## GOLD.—1861.

During this year, for first time, Gold, in sufficient quantity to demand a section of our Mineral Returns, was produced from the Vigra and Clogan Mines, in Merionethshire, to the extent of 2,886 ounces 3 dwts., the value of which was £10,816 17*s.*

## SILVER.

Quantities and Total Value of Silver extracted from Lead Ore raised in each county in England and Wales, and in the Isle of Man, Scotland, and Ireland, in each of the years, 1859, 1860, and 1861.

| Counties. | 1859. | 1860. | 1861. |
|---|---|---|---|
| | Ozs. | Ozs. | Ozs. |
| ENGLAND. | | | |
| Cornwall .. .. .. .. | 215,964 | 180,757 | 173,344 |
| Devon .. .. .. .. .. | 66,875 | 53,059 | 45,187 |
| Cumberland .. .. .. .. | 39,406 | 32,806 | 37,115 |
| Durham and Northumberland .. | 74,222 | 84,254 | 87,265 |
| Westmorland .. .. .. | 431 | 1,695 | 21,214 |
| Staffordshire .. .. .. .. | — | — | 125 |
| Yorkshire .. .. .. .. | 1,178 | 3,385 | 3,650 |
| Shropshire .. .. .. .. | — | — | 1,317 |
| Derbyshire .. .. .. .. | 3,000 | — | 1,000 |
| Somersetshire .. .. .. .. | 950 | 850 | 850 |
| Cheshire .. .. .. .. | 150 | 45 | 95 |
| Total for England .. .. | 402,176 | 356,853 | 362,162 |
| WALES. | | | |
| Pembroke .. .. .. .. | — | 1,116 | 400 |
| Cardigan .. .. .. .. | 37,787 | 44,807 | 54,989 |
| Carmarthen .. .. .. .. | 1,700 | 1,310 | 2,680 |
| Denbigh .. .. .. .. | 14,318 | 16,661 | 20,539 |
| Radnorshire .. .. .. .. | 125 | 175 | — |
| Flint .. .. .. .. .. | 22,693 | 31,092 | 25,779 |
| Montgomery .. .. .. .. | 6,036 | 7,665 | 11,169 |
| Merioneth .. .. .. .. | 962 | 1,076 | 988 |
| Caernarvon .. .. .. .. | 480 | 1,162 | 990 |
| Total for Wales .. .. | 84,101 | 105,064 | 117,534 |
| Isle of Man .. .. .. .. | 56,974 | 60,170 | 67,282 |
| Scotland .. .. .. .. | 4,022 | 3,140 | 4,133 |
| Ireland .. .. .. .. | 13,998 | 14,365 | 12,398 |
| Sundries .. .. .. .. | 346 | 277 | 222 |
| Silver from (Silver Ore) .. .. | 16,660 | 8,871 | 5,799 |
| Total for United Kingdom | 578,277 | 628,740 | 569,530 |
| | Estimated Value. | | |
| | £ 158,407 | £ 172,903 | £ 144,161 |

## GENERAL SUMMARY FOR 1861.

| Minerals. | | Quantity. | Value. |
|---|---|---|---|
| | | | £ |
| Tin .. .. .. .. .. .. | Tons. | 11,640 | 725,560 |
| Copper .. .. .. .. .. | „ | 231,487 | 1,427,215 |
| Lead .. .. .. .. .. | „ | 90,696 | 1,136,249 |
| Silver Ore .. .. .. .. .. | „ | 29 | 1,471 |
| Zinc Ore .. .. .. .. .. | „ | 15,770 | 31,113 |
| Pyrites .. .. .. .. .. | „ | 125,135 | 79,715 |
| Arsenic .. .. .. .. .. | „ | 1,450 | 10,875 |
| Nickel .. .. .. .. .. | Cwts. | 16 | 24 |
| Wolfram .. .. .. .. .. | Tons. | 8 | 29 |
| Antimony .. .. .. .. .. | „ | 15 | 45 |
| Manganese .. .. .. .. .. | „ | 925 | 2,925 |
| Sundries—Gossan, Ochre, &c. .. | „ | 3,016 | 3,016 |
| Iron Ore .. .. .. .. .. | „ | 7,215,518 | 2,302,371 |
| Coals (sold and used) .. .. | | 83,635,214 | 20,908,803 |
| Other Minerals .. .. .. | | 2,222,602 | 880,114 |
| Total Value of the Minerals produced in 1861 .. .. | | — | £27,509,525 |

## METALS PRODUCED FROM BRITISH MINERALS.

| | | Quantity. | Value. |
|---|---|---|---|
| Gold .. .. .. .. .. | Ozs. | 2,784 | 10,816 |
| Tin .. .. .. .. .. .. | Tons. | 7,450 | 910,762 |
| Copper .. .. .. .. .. | „ | 15,331 | 1,572,480 |
| Lead .. .. .. .. .. | „ | 65,643 | 1,445,255 |
| Silver .. .. .. .. .. | Ozs. | 569,530 | 144,161 |
| Zinc.. .. .. .. .. .. | Tons. | 4,415 | 79,101 |
| Iron, Pig .. .. .. .. .. | „ | 3,712,390 | 9,280,975 |
| Total Value of the above .. .. | | — | 13,443,550 |
| Estimated Value of other Metals .. | | — | 250,500 |
| Coals .. .. .. .. | | — | 20,908,803 |
| Total Value of the Metals produced, and Coals .. .. | | — | £34,602,853 |

This enormous amount of wealth is annually produced from our rocks by the exercise of human industry. In our collieries, too, a vast amount of merely animal force is employed under the direction of a few individual minds trained to the duties. Method has usually been fairly introduced, and the colliery owner, under the guidance of the viewer, has availed himself of that knowledge which science can only give. The lamentable casualties, however, which are continually recurring, prove that there is yet much to do in the way of instruction; and let me ask is it not in evidence that the great loss of life, which is shown by the Colliery Inspector's report, amounting to about 1,000 in each year, as the following summary for ten years will show, is chiefly due to the ignorance and consequent obstinacy and recklessness of the working men:—

Summary of Lives Lost in the Coal Mines of the United Kingdom for the Ten Years ending 1860.

| Years. | Lives Lost. |
|---|---|
| 1851 | 1,062 |
| 1852 | 671 |
| 1853 | 755 |
| 1854 | 779 |
| 1855 | 728 |
| 1856 | 1,033 |
| 1857 | 1,118 |
| 1858 | 939 |
| 1859 | 901 |
| 1860 | 1,104 |
| Total lives lost | 9,090 |

The mind of man is only brought under the control of reason by persevering efforts long continued. The soldier is carefully trained to act under the guidance of an individual mind. He is taught to know that his own safety, and that of those with whom he is banded, depends upon implicit obedience to the guiding head, and almost daily drill is found necessary to maintain this discipline. The hosts of miners who have to face death in other and yet more terrible forms than appear on the battle-field, are left to train themselves to their subterranean toils, and remain untutored to the end in any of those departments of knowledge which would bring their wild impulses under the control of reason, and arm them with the means of avoiding the dangers into which they impetuously rush I cannot, however, on this occasion venture further upon this. My purpose is rather to deal with the metalliferous mines, minerals, and miners.

I feel assured that in Nature there is no uncertainty; that the mineral veins, with all their apparent irregularity, are as dependent on some fixed law as is the motion of our satellite, and the recurrence of the tides on our shores. The earth was given to man that he might subdue it, and brute matter, with the physical forces in connection with it, can only be brought under subjection by the influence of mind. No discovery was ever made without great labour. To work and wait is man's destiny, and unless he will bring his industry to bear on any subject, and train himself to patience, the truth will not be disclosed.

To observe correctly requires close and constant training. The senses deceive us, and unless we are ever on the watch, our minds advance under the influence of imagination more rapidly than is consistent with the mining for truth to which we are compelled to submit. To remove mining therefore, from the system of guesses, which now rules it, a system of method must be introduced. Education, and education of that character which is peculiarly scientific, is the only means by which we can give greater certainty to the exploration of our metalliferous rocks.

By training young miners to observe correctly, by directing their observation, and compelling them to make an exact note of every fact, however trivial it may at first appear to be, we should obtain a record of conditions which would probably in a little time guide the philosopher towards the laws by which the metals have been deposited as ores in veins. No one can deny, if he has paid any attention to the conditions of the mineral lodes, be they of tin, copper, or lead, that there are evidences of certain constants in the mode of their occurrence. This being acknowledged, why do we not at once organize the method by which the more exact information may be obtained? I have been told that the miner will not be educated, and the failure of some mining schools has been brought forward in proof ·· t knowledge is distasteful to the labourers in our mines. I am placed ·e very happy position of being able to deny the assertion.

Schools for miners were established at such a distance from the mines and the miners' homes that it was impossible for the man who had laboured eight hours in the dark recesses of the earth, and toiled for an hour on perpendicular ladders in climbing to the surface to attend the school. The effort, it appeared to me, should be made, seeing that the miner could not go to the school, to take the school to the miner. I have worked to this end, and organized the Miners' Association of Cornwall and Devonshire. With very limited subscriptions from the mineral proprietors and from others connected with the mines, ten classes have been established in as many mining centres. In these classes are taught, by qualified teachers, chemistry, mineralogy, mechanics, surveying, and mechanical drawing. Each of these classes is well attended by working miners, and the applications made to the Council of the Miners' Association to establish yet other classes in other districts are urgent, and, unfortunately, at present beyond the means at their disposal.

That we have to contend with the prejudices of the older miners is certain. We have, however, passed through the period of active opposition, though still we have to combat the silent repressory efforts of those whose game is speculation, and whose living depends on the uncertainty of ignorance. These must fail before that steady perseverance in a good cause, which will, I believe, distinguish the progress of the Miners' Association. So far as the experiment has been carried, it has proved a success. A most earnest desire has been manifested by the young miners to learn those branches of science which it is thought right to introduce in the classes. The utmost care is taken to avoid in every way any interference with the labours of the miner; he is only taught those sciences which are directly available to his bread getting, and only so much of these, as appears necessary to the proper training of the miners' mind.

Experience has proved that it does not do to force knowledge of any kind on the untrained mind. It is rejected if the attempt is made, consequently the Miners' Association, having prepared its machinery, waits the invitation of those for whose benefit it is intended; and no teacher is sent into a district until a class of not less than ten members is formed, and these members agree to subscribe to the general fund. The subscriptions are small—five shillings a year from the working miner, and not less than ten shillings a year from the mine agent or manager. In addition to the system of class instruction, periodical meetings are held for the purpose of reading communications from the miners on the several subjects connected with the conditions of, and the working of, the mines, the mechanical appliances necessary, and the modes of preparing the ores for the market. In this way it is hoped, by slow but sure degrees, to introduce an improved system into a district where, with the tenacity of the ancient Celt, they still cling to the practices of their fathers.

That which has been done, which is now doing in Cornwall and Devonshire, may be done elsewhere. We have, it is true, mining schools at Glasgow, at Wigan, and at Bristol. I am only personally acquainted with the school at Glasgow, which progresses in a most satisfactory manner. But what are these amidst the masses of miners spread over the length and breadth of our islands Let us examine, with as much correctness as we can, the conditions which exist.

In Great Britain there are—

| | | | | |
|---|---|---|---|---|
| Coal Mines .. .. | 3,000 | employing | 250,000 | persons. |
| Iron Mines .. .. | uncertain | „ | 27,000 | „ |
| Copper Mines .. | 167 | „ | 22,000 | „ |
| Tin Mines .. .. | 148 | „ | 14,500 | „ |
| Lead Mines .. .. | 390 | „ | 21,500 | „ |
| Zinc and others .. | — | „ | 1,000 | „ |
| Making a total of .. .. .. | | | 336,000 | „ |

actually engaged in mining operations; this is exclusive of quarries of all kinds.

Out of this 300,000 there certainly are not more than 300 under any such course of instruction as is necessary to fit them properly for the labours to which they are destined. We boast of our educational progress. We teach reading and writing in every, the remotest, corner of the land, and there we stop. We instruct our children in a knowledge of the signs by which ideas are expressed, but we leave them to gather ideas by any accidental means which may present themselves. We put tools into the hands, but we trust to chance for the knowledge of the way to use them.

I do not think it necessary to discuss further the question of the worth of knowledge to the working man. The unfortunate evidence which is constantly recurring of the loss of life in our collieries and mines, convicts us all as a people of great carelessness. The pyramids of Egypt were built by mere brute force controlled by a despot's hand, and guided by some master mind. Some of our vast engineering works, our railway tunnels and our railway cuttings have been executed under the same circumstances. We have gone on trying the experiment in our mining operations, and every accident proclaims that the system does not answer. If we would save life we must educate the living in the causes of danger, and teach them the means by which these may be guarded against. The ventilation of a colliery may be the best possible, the truest science may have been brought to bear on the problem, and in obedience to exact laws, everything may have been arranged. Then, having taken all this care, having expended all this thought, time, and money, we leave it to the mercy of any individual man, out of many hundreds of ignorant men, who through their very ignorance, are thoughtless, reckless.

Again, hundreds of thousands of pounds are expended annually in the exploration of our mineral districts. There is a rare—a tempting—supply of minerals in these islands. We have gold and silver, copper, lead, tin, zinc, antimony, nickel, cobalt, bismuth, uranium, chromium, and other of the rare metallic minerals, not to mention our vast stores of iron; coal beds, which are enormous, but which we are wilfully wasting, and earthy minerals of great value. The hoarded treasures are mined for by men who burrow, as does the mole, without any guiding light. The result is that mining for metallic minerals is not, on the whole, remunerative, whereas it is the expressed opinion of men whose experience entitles them to attention, and whose utterances are the result of careful thought, that no industry should yield so fair a profit if prosecuted with judgment, and carried forward with the necessary knowledge and consequent economy. It may be asked what can be done to remedy the evils which I have described? The one only remedy is a correct, a fitting education. By this I mean instruction in such truths as will serve as guiding and as warning lights. I do not dream of making miners men of science—I would avoid that superfluous knowledge which does tend, in poor, fallible human nature, to generate conceit. I would not attempt to teach mining in a school. The only school in which mining can be taught is the mine itself; but I would bring in aid of that practical teaching on which we must insist, those aids which have been afforded by the investigations of true science. At a small cost, in each mining district, schools might be cheaply established, and the means afforded for the acquirement of that modicum of knowledge which is really required. If desired, in well-selected centres, a yet higher class instruction might be given to those who had shown they had the industry and ability to deserve those larger advantages. From these, again, might be gleaned the more remarkable young men, and to them might be offered the full scientific education which is afforded by such an establishment as the Royal School of Mines.

A commission has been, during the year, most industriously at work, inquiring into the conditions of our metalliferous mines and the health of

our miners. We must wait for their report, which (appear when it may) will be a most important record of facts. Whatever may be the advice of the commission to the Government, of this I am assured :—That money will continue to be squandered in lavish expenditure on mines that are unworthy of trial; that wealth will be wasted through the errors of ignorance; that dreadful casualties will continue to horrify us; and that the miner will perish ere yet he has reached the number of his days; until we have crushed out that dark ignorance which spreads over all like a fungus, and have planted in its place some of the seeds from the tree of knowledge.

# Notes and Memoranda.

SHEFFIELD SCHOOL OF PRACTICAL SCIENCE AND METALLURGY.—The first term of this school being now on its close, it may be interesting to our readers to have some information as to its progress. According to the plan of instruction drawn up by the director, the studies have included geometry, algebra, trigonometry, civil engineering, inorganic chemistry, with laboratory practice and mechanical drawing; and we are happy to say that the number of students attending these various classes is already such as to assure the success of the school. Indeed the classes of the Sheffield School of Science have been attended by nearly as many pupils as entered on the opening of the Royal School of Mines in 1851. The lectures to working men appear also to have been a complete success.

GEOLOGICAL SURVEY OF CALIFORNIA.—We have received from Dr. J. D. Whitney, the State Geologist, a notice of the progress of this survey up to May, 1863. The operations have now been in progress a little more than two years, having commenced in December, 1860; but they seem to have been retarded by the disturbed state of the country, and the unfortunate condition of the finances of the State, which has kept the treasury one or two years behind in payment of appropriations. A difficulty seems also to have been met with from the want of accurate maps. California is covered by a vast net-work of mountain ranges, with comparatively narrow valleys, with the exception of those of the Sacramento and San Joaquin, which together do not cover an area of one-fifteenth of the State. Into this mountain region—part of which, the chain of the Sierra Nevada, is compared with the Alps for extent and average elevation—no accurate surveys have been carried; and consequently the completion of maps is necessarily the first task of the survey. Six of these are now reported to be in course of preparation, on scales ranging from ½″ to 6″ to the mile—and a seventh is in contemplation. Dr. Whitney points out, that in a State of such immense area as California, their labours hitherto have been necessarily more in the nature of a reconnaissance than a detailed survey; but already he reports that a large amount of information has been collected in regard to the mode of occurrence and the abundance of the useful ores and minerals of the State and the adjoining Territories. The principal deposits of coal have been carefully examined, and their geological position ascertained. Most of the important quartz mines of the State have been visited, and a large amount of information collected, preparatory to an elaborate investigation and report on this important branch of the industry of the Pacific coast. Altogether the work seems to be progressing as well as can be expected, and certainly it could be under no abler direction than that of Professor Whitney.

GEOLOGICAL SOCIETY OF DUBLIN.—At the meeting of this Society on May 13th, a communication was read from Dr. T. S. Hunt, containing some additions to his paper on "The Chemical and Mineralogical Constitution of Igneous Rocks," read at the last meeting. Dr. Hunt states that since writing his paper

evidence obtained by Sir William Logan renders it probable that the great mass of anorthosite rocks, hitherto referred to the Laurentian system, may really belong to a superior formation, resting unconformably upon the Laurentian. This oldest system contains small beds of anorthic felspar rocks, forming varieties of diabase, and representing the second class of aluminous sediments. These, however, appear on a much greater scale in the second group of rocks, to which the name of the Labrador series may be provisionally given. This series, although newer than the Laurentian, is more ancient than the Lower Silurian, or even than the Huronian, and includes, like these, beds of crystalline limestones, iron ores, and quartziferous orthoclase gneiss. Altogether the predominance of anorthorites is characteristic of the series which is met with in several areas among the Laurentide hills from Labrador to Lake Huron, and which also covers a considerable region in northern New York, where, according to Dr. Emmons, the anorthosites form the summits of the Adirondach Mountains.

At the meeting of June 10th, a paper was read by the Secretary, Mr. R. H. Scott, "On the Fossils of the Yellow Sandstones of Mountcharles, Donegal," in which he described the discovery in it of a large number of well-known carboniferous mollusca, associated with plants and some other markings which he considers to resemble fish-scales. This discovery proves the sandstone in question, as well as some similar deposits in the North of Ireland, to be of Carboniferous instead of Old Red Sandstone age--which is important as showing the correlation of the Lower Carboniferous beds of the North and South of Ireland.—After this the Rev. Dr. Haughton read a paper "On Primary and Secondary Joints, and their Mechanical origin," in which he showed how the various systems of joints which are observed in rocks might have been produced by pressures acting in certain directions on the masses of rock which form the district. On this paper Mr. Jukes remarked on the great advantage proposed by the society in having as one of its members a man possessed of such varied attainments as Professor Haughton, whose extended knowledge enabled him to approach difficult questions in their science from aspects quite unanticipated by other members. He was himself inclined to attribute the formation of primary joints to the contraction, on consolidation, of the rocks in which they occurred.

Manchester Geological Society.--The monthly meeting of members was held on Tuesday, May 19th, in the Museum, Peter-street, the President Mr. J. Dickinson, F.G.S., in the chair. A paper was read by Mr. Binney on the Geological Formation of the Site occupied by Manchester; and some shells were presented by Mr. Brammall from the drift at Rainford. A discussion also took place as to the relative merits of the various safety-lamps now in use, the general opinion being that the Stephenson and Mueseler lamps were more valuable than the Davy, as the former were extinguished by fire-damp, while the latter would explode.

The Freiberg Mining Association.—At a meeting of this Society, on February 10th, Herr von Cotta referred to two papers sent him by old pupils: by Thomas Macfarlane on the Acton Copper Mine, in Canada, from the *Canadian Naturalist* for December, 1862, and by J. D. Hague, on the Guano Islands of the Pacific. At the meeting of February 24th, Herr von Cotta laid before the members Dr. C. Grewingk's Geology of Liv- -und Kurland, illustrated with maps. Herr von Scheerer communicated some of the results of the late investigations into Norwegian geology as regards the oldest crystalline rocks.

Treatment of Auriferous and Argentiferous Copper Ores.—An improved mode of manufacturing copper from copper ores has been provisionally specified by Dr. T. Fleitmann, of Iserlohn, Prussia, according to which the copper ores are first ground to powder; then one part of such powder is roasted dead, and mixed with the unroasted portion, and the whole melted with a suitable flux, such as silica or the slag of a previous process. The melted mass is run into water, and the product ground to powder; and the process repeated until the resulting sulphuret of copper is in the desired condition. The sulphuret of copper obtained is ground to powder and roasted dead, then moistened with an alkaline solution. The oxide of copper is subjected to heat to melt the alkali, but not the oxide of copper, which is then well washed in water: the product obtained is mixed with powdered carbon, and then melted.

# Legal Notes.

A NOVEL, and probably as difficult a question of law as ever came before a court of justice was argued, in the case of *Hodgkinson v. Ennor*, before the Court of Queen's Bench on May 29 last. The defendant is a mine-owner, working certain refuse lead-slags, the remains of very ancient smelting operations, at Priddey Minery, on the Mendip Hills. In order to extract the lead from these slags they have, of course, to undergo the operation of washing, and the water coming from this operation is allowed to run into the "swallets" or "swallows," very numerous on the Mendip Hills as in other limestone districts. In the "case" stated to the Court, these "swallets" are described as rents in the limestone rock, open to the surface at the summits of the hills, communicating, by an underground passage, with an outlet at the foot of the hills by which the water that enters at the surface-openings escapes in an open stream. The plaintiff is the proprietor of paper-mills at Wokey Hole, in Somersetshire, and he brought his action against Ennor for the pollution of the water-course supplying his mills. The cause came on for trial at the Wells Assizes in 1861, but there was no verdict, it being agreed that the facts should be stated in a special case, which now came on for argument. It was admitted that the plaintiff suffered an appreciable damage; but it appeared that his mills were about a mile and three-quarters from the defendant's works, and that the quantity of polluted water the latter allowed to flow into the "swallets" was trifling compared with the total bulk of water supplied by "swallets" to the stream used by plaintiff—viz., 16 gallons per minute, compared with 16,000 gallons.—Various points were raised by the defendant; but the substantial defence was, that although if the case were one of an open water-course there was no answer to the action, yet the water-course being subterranean no action could lie according to the decision of the House of Lords in the great case of *Chasemore v. Richards*. On the part of the plaintiff it was contended that that case applied to the *diversion* of underground springs, but not to their *pollution*; and the Lord Chief Justice pointed out that the great grievance was the pollution, not of the underground springs, but of the water-course into which they ran. The defendant's counsel urged that there was a peculiar law as to subterranean water; that his client only polluted the subterranean springs, which he had a right to do, and that the mere fact that they afterwards ran into the water-course did not make him liable. The Lord Chief Justice, however, pointed out the distinction between merely preventing the water from coming into the stream, and polluting all that was in the stream, and the opinion of the Court was that the case was clear against the defendant. The plaintiff was entitled to the flow of water into the stream in a pure state, and the defendant threw polluting matter into a place whence it must and did flow into the stream. In common sense, and as they thought in law, that was actionable.—Judgment for the plaintiff, in which the other Judges concurred.

The cause of *Readwin v. the Vigra and Clogau Copper Mining Co. (limited) and others*, came on, before Vice-Chancellor Sir R. T. Kindersley, on June 2, upon two demurrers for equity—one of the company, and the other of Charles Martin, a defendant. The plaintiff had been the holder of six hundred shares in the above company, which shares had been declared forfeited, and afterwards disposed of by the directors to Martin, and the object of the bill was to have both the forfeiture and the sale to Martin declared void. The mines are situated near Dolgelly, in Merionethshire, and it appeared that the company was formed in 1858. The transactions sought to be set aside occurred in February, 1860, and in December of that year a shoot of gold was discovered on the St. David's lode, since

which time gold to the amount of 31,000*l.* had been raised, and dividends also declared to the amount of 21,000*l.* from profits derived from this metal.—After the first demurrer had been opened, his Honour suggested that the question might be argued at the hearing, and it was ultimately agreed that the demurrers should be overruled without prejudice to any question in the cause. Cost reserved.

In the matter of *The Arbitration between the Adventurers of Wheal Mary Mine and Wheal Kitty Mine*, cause was shown before Mr. Justice Mellor, on June 9, against a rule to set aside the award of Captain Charles Thomas defining the limits of these respective mines, on the ground that he had, as arbitrator, exceeded his authority and had not fully decided on the matters referred to him :—The learned Judge suggested that the better plan would be to send the award back to Captain Thomas with a strong recommendation that he should call in a legal gentleman to assist him, that gentleman to be named by the learned counsel in the case. After some consultation, this course was agreed to.

On the 19th June the House of Commons went into committee on the Alkali Works Regulation Bill. Mr. Bruce states that it had been introduced upon the recommendation of a select committee of the Upper House, who had found that, in the neighbourhood of St. Helen's and other towns, trees and vegetation were injured. Some years ago means were discovered of condensing the injurious gases, which had been adopted by the principal manufacturers but not by all. The only check at present was an action for damages, or an indictment, both of which he pointed out were beset by difficulties. Great numbers of the leading manufacturers acquiesced in the proposed legislation; and the reason why the bill was applied to this particular manufacture only was that in its case an undoubted remedy had been discovered, which could not be said of other classes of works. It was admitted that the bill was new in principle, for it instituted an inspection in the interest of property, and not for the safety of the workmen. Mr. Vivian pointed out the importance of the interest about to be controlled. The alkali manfacture consumed 1,761,000 tons of raw material, and produced 280,000 tons of finished goods, of the yearly value of 2,500,000*l.* The capital involved in the trade somewhat exceeded 2,000,000*l.* The hands directly and indirectly employed were nineteen thousand, involving the maintenance of nearly one hundred thousand souls. The wages paid were 871 750*l.* per annum. The trade gave employment to a large quantity of shipping, for the estimated tonnage of the raw materials and finished goods was 2,500,000 tons. Some of the most important and most necessary articles of life were dependent for their cost on the production of alkali. Petitions in favour of amendments had been agreed to by the Chamber of Commerce in various towns, and he hoped the committee would introduce the clauses which the manufacturers deemed necessary for their protection. It was a peculiar trade, and depended, for its cheapness of manufacture, on the accessibility of the manufacturers to salt, pyrites, coal, and limestone. One of the amendments he proposed would be power of appealing from local tribunals to a higher court.—Mr. Bouverie doubted altogether the policy of the measure, and would move that its duration be limited; but Lord Stanley denied that it was an act for the exclusive protection of the landed interest—it was also for the protection of the inhabitants of the neighbourhood. Mr. Henley objected to the quarter sessions being selected as the tribunal for the prosecution of offences under the Act; but Lord Stanley pointed out that it was open to the committee to substitute the county court and a jury.—Clauses limiting the operation of the Act to alkali works, and enacting that 95 per cent. of the muriatic gas evolved shall be condensed, were agreed to; and also one that no owner shall be convicted of more than one offence in any one day. Mr. Bright suggests that, as manufacturers had met the matter fairly and liberally, the com-

**mittee should accept the amendment they suggested.—On Clause 12, that offences under the Act should be prosecuted before the quarter sessions, Mr. Henley objected that that court wonld be both judge and jury at once; and Mr. Bright would rather have the case tried before a jury and county court judge, for he apprehended that the magistrates, as landowners, might carry a little prejudice into the case. Mr. Vivian said such a transfer would be acceptable to the manufacturers; but Mr. Bruce objected that it would give a new jurisdiction to county courts, who at present had no power to inflict penalties.—On government being appealed to, Sir G. Grey said he preferred to jurisdiction of quarter sessions; but after some observations from Mr. Cobden, he stated that government was prepared to give some appeal from quarter sessions, which appeared to be satisfactory to the manufacturers.—Mr. Vivian moved a new clause, enacting that, in the case of offences committed by workmen without the knowledge and against the orders of the owner, the workman should be liable to the penalty; which was agreed to on a division; and it was also agreed, on the motion of Mr. Bouverie, that the duration of the Act be limited to 1st July, 1868.**

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## Mining, Quarrying, and Metallurgical Review.

### WESTERN COUNTIES.

There is little worthy of notice to mention in Cornish mining. The advance in the tin and copper standards is encouraging, and tin miners are now looking for the old prices of three years ago.

The greatest present activity seems to be in the Perranzabuloe and Newlyn districts, where new mines are springing up every week—particularly in the neighbourhood of Chiverton. Among others at the *North Shepherds* mine an engine is about being erected, a cost-book company, divided into 2,000 shares, having been formed, 500 of which (2*l*. paid) are allotted to the vendors, who have been working for some time at the adit. The mine is under the management of Captain Thomas Richards.

At the last *Pedn-an-Drea* meeting, it was resolved to divide the sett and work the southern ground—the old Sparnon mine—as a separate concern. There can really be no second opinion as to the expediency of this course, which indeed should have been carried out a couple of years ago. The position of the old mine seems to be steadily improving, but it would be most unwise to encumber it with the large outlay required for a new concern. The Sparnon ground is generally considered as one of the best speculations in the Redruth district, for it is on the same run of lodes as East Carn Brea, and on the parallel of rich mines.

The principal improvements in mines during the month have been in West Tolgus, Sithney Carnmeal, and Prosper United. At *West Tolgus* the lode in the shaft is looking very well, and there can be little doubt that the mine will be almost at once in a position to pay dividends. At *Sithney Carnmeal*, in the 75 west of Flat-rod shaft, a fine lode of tin was met with, but the end has since fallen by being disordered by a slide. The discovery is, however, considered one of much importance in the district, as the lode here is precisely similar in character to that at *Great Fortune* on the top of the great bunch of tin. At *Prosper United* a fine lode of copper is being opened out between the 69 and 70 fathom levels in the western mine. This mine has now weathered all its troubles, and is about paying cost;

indeed there seems every appearance of it realising some of the great promises made on its starting. *East Carn Brea* has also improved, as have also *EastRosewarne* and *Wheal Arthur*.

At the last meeting of *Alfred Consols*, it was resolved to abandon the mine—which could only be carried on at a very heavy loss, and by an outlay which the adventurers are disinclined to make. At *West Par* meeting (May 27th) it was resolved that application be made to Major Carlyon, urging him to suspend the dues, at all events temporarily. At *Drakewalls* meeting (May 26th) it was resolved to work the West Drakewalls sett as a separate adventure.

The trading harbour of *Gweek*, at the head of the Helford River, near Helston, has been purchased from Messrs. Cornish and Borlase, the old firm, by the Messrs. Williams, who will no doubt throw new enterprise and energy into the district.

A new tin smelting company has been formed in Truro, by Mr. John Gatley, of Tresillian, in connection with Captain Bawden, late of the Trethellan works (Messrs. Williams and Co.) Mr. Gatley and his friends have purchased the freehold of the old tin smelting works, in Tregolls-road, Truro, which were erected nearly eighteen years ago, by Mr. William Revell Vigers and party, at a considerable cost, but which have for a long time been unoccupied. A few years since there were only three tin smelting firms in Cornwall, and there are now eight, four of which have been started very recently.

The Vice Warden has given notice that the Stannaries' assessment of one farthing in the pound on the value of all metals and metallic minerals will not be required for the last half year, there being sufficient funds in hand.

A new concern is started at Marazion, called *South Grylls*.

## WALES AND THE BORDERS.

South Wales.—Although no very large amount of business has been transacted in this district, still the works have been going on with great regularity, and there has been a steady demand. During the last nine months a substantial improvement has taken place in the state of the iron trade of South Wales, and the result is that the works are better employed, and there is a very considerable increase in the number of furnaces in blast. It cannot be said that the trade is in anything like a prosperous state, but the depression of the last four years seems to be gradually disappearing, and a more promising and hopeful feeling has taken its place. The best evidence of this fact is in the actual extension of works that were kept going during the depressed times, and the number of old works that have been, or are about to be, brought into life again. Among the extensions and improvements may be mentioned the lighting of an additional furnace at Ebbw Vale, Abersychan, and Llwydcoed respectively, the erection of a new mill at the Plymouth works, and also extensions at Sirhowy, Aberdare, &c. The old works revived are Varteg, where two furnaces have been put in blast; Golynos, where two others are about to be lighted; and the Cwmbran forge will recommence working without delay. The Venallt furnaces are also likely to be started again, and if the present improving tendency of the trade should continue there are hopes that something will be done at Hirwain and Treforest. An extensive new establishment—the Marshfield Ironworks, near Llanelly—has lately been started, for the special object of producing armour-plates. These facts, and others which might be mentioned, clearly show that the iron trade of the district is gradually emerging from the depression which has characterised it for so long a time.

The coal trade has been fairly active during the month, and the collieries have been kept going pretty regularly; although the trade has been a good deal hindered by the want of ships. The Machen Company have just struck the Lantwit vein at their new colliery at Bedwas. The seam has been struck at the depth of 147 yards, about 40 yards of which had to be reached by boring, and the thickness of the coal is 4ft. 5 in. The shaft is now down nearly 120 yards, and in another three months the colliery is likely to be in working order. The returns for May show a considerable decrease in the trade of Cardiff. During the month 391 vessels cleared the port, and the exports were 103,210 tons of coal, 17,769 tons of iron, 1,580 tons of patent fuel, and 1,086 tons of coke, being a decrease of about 20,000 tons of coal and 4,000 tons of iron as compared with the preceding month. The total exports for the five months have been 572,894 tons of coal and 67,173 tons of iron, which is a small increase as compared with the corresponding period of last year. The decrease in the shipments during the month of May was mainly attributable to the adverse winds which prevailed, and the consequent scarcity of tonnage.

From the statistical returns of the trade of Swansea during the month of May, it appears that quite an average business was done. The total number of vessels entering the port during the month were 549, with an aggregate registered tonnage of 56,378, whilst the shipping rates received were 1,416*l.* 12*s.* 0½*d.* Compared with the corresponding month of 1862, there was an increase in the number of vessels, but a slight decrease in both the registered tonnage and the shipping rates received, the principal decrease being in the coasting and European trades.

The emigration from the South Wales district instead of lessening, as expected, is steadily increasing day by day. The majority of the emigrants are colliers and puddlers employed in the coal and iron works, and many also leave from the agricultural districts. As instances of the extent of the emigration, whole streets of houses have been vacated the same week at Aberdare, Merthyr, &c., and no less than forty workmen are at present working their notice out at the Cyfarthfa Iron works with the view of emigrating. This extraordinary drain has naturally excited the apprehension of large employers of labour, and if it should continue it is evident that considerable difficulty will be experienced in keeping the extensive coal and iron works of the district going.

CARDIGANSHIRE.—The prospectus has been issued of the *Darren Consolidated and Silver Lead Mining Company*, limited, with a capital of 30,000*l.*, in shares of 2*l.* each. The property to be worked is situated six miles from Aberystwith.

GLOUCESTERSHIRE.—Among the imports into Bristol during the month have been: 276 tons of sulphur ore from Pomaron; 130 tons of sulphur ore from Arklow; 80 casks of metal from Rotterdam; 86 tons of lead ore from Newquay, 20 tons from Aberystwith, and 80 tons from Douglas; 400 tons of pig-iron from Glasgow and Belfast; 200 tons of iron from Newport; 7 barrels of sulphur and 16 casks of lead ore from Liverpool; and 60 tons of silver-lead ore from Plymouth. Among the exports were: 400 tons of coal, and 900 tons of iron.

The imports into Gloucester have included 155 tons of sulphur ore from Pomaron; 60 tons of pig-iron from Swansea; 143 tons of pig-iron from Ardrossan; and 50 tons of coal from Landshipping. Among the exports were: iron for Waterford, Plymouth, Hayle, Cork, Carmarthen, and Port Madoc.

## MIDLAND COUNTIES.

STAFFORDSHIRE AND WARWICKSHIRE.—The trade of this district is still in an unsettled state, owing to the continued strike of the puddlers. Prices,

however, are likely to be firmer in consequence of the supply being reduced by the blowing out of some furnaces. The chief demand is for plates, for which there has been an active enquiry. The furnaces blown out are one at Millfield, one at Tipton, and one at Cosely. By these reductions the make of the district will be reduced to between 5 and 600 tons a-week.

The coal trade is not in such a satisfactory condition, the continuation of the puddlers' strike having naturally exercised an unfavourable influence on it.

## NORTHERN COUNTIES.

NORTHUMBERLAND AND DURHAM.—The iron trade is in rather a more favourable condition than was the case last month. It is said that the Consett ironworks are to be sold. At Jarrow three furnaces are now in blast, and it is expected that a fourth will soon be added.

The following shows the number of blast-furnaces in operation in the Cleveland and South Durham districts at the beginning of June :—

| Places and Owners. | In. | Out. | Total. |
|---|---|---|---|
| Eston — Bolckow and Vaughan .. .. .. | 9 | — | 9 |
| ,, Clay Lane Company .. .. .. | 3 | — | 3 |
| ,, Samuelson and Company .. .. .. | 3 | — | 3 |
| Cargo Fleet—Jones, Dunning and Co. .. .. | 2 | — | 2 |
| ,, Cochrane and Company .. .. | 4 | — | 4 |
| ,, Gilkes, Wilson, Pease and Co. .. | 4 | 1 | 5 |
| Middlesborough—Bolckow and Vaughan .. .. | 3 | — | 3 |
| ,, Hopkins and Co. .. .. .. | 1 | 1 | 2 |
| Port Clarence—Bell Brothers .. .. .. | 5 | 1 | 6 |
| Norton—Warner, Lucas and Barrett .. .. | 3 | — | 3 |
| Stockton—Holdsworth and Company .. .. | 3 | — | 3 |
| Ferry Hill—J. Morrison .. .. .. .. | 3 | — | 3 |
| Thornaby—W. Whitwell and Company .. .. | 3 | — | 3 |
| Darlington—South Durham Company .. .. | 3 | — | 3 |
| Whitton Park—Bolckow and Vaughan .. .. | 4 | — | 4 |
| Stanhope—Weardale Iron Company .. .. | — | 1 | 1 |
| Towlaw—Weardale Iron Company.. .. .. | 4 | 1 | 5 |
| Consett—Derwent Iron Company .. .. .. | 5 | 13 | 18 |
| | 62 | 18 | 80 |

A larger number than has ever been recorded as in existence in these districts, and at the same time the percentage of furnaces out of blast is much smaller.

The coal trade continues extremely dull. On the Tyne the steam collieries are working about seven or eight days a fortnight, and much the same state of things prevails on the Wear. A very interesting report has been made to the River Tyne Improvement Commissioners by Mr. T. E. Foster and Mr. John Taylor, two of the leading coal owners and coal viewers in Northumberland, relative to the existing state and prospects of the Northumberland Steam Coal field and the quantities that may be expected to be shipped therefrom upon the Tyne. These gentlemen report that they have measured the respective royalties in which is being wrought at the present time the Low Main, or best steam coal of the district; and after making full allowance for the quantity already excavated, loss by dykes, small coals left under ground, and screened out on the surface, they

find that there is sufficient to endure, in the present rate of shipment of steam coal on the Tyne, in addition to the portion diverted to Sunderland Dock, for a period of one hundred and ten years. But the present collieries could produce from 20 to 25 per cent. more than they do at present, were the demand to arise. On this head there would be an increase of, say 300,000 tons; a new colliery is being opened out at Camboise, from which may be computed an annual vend of 160,000 tons, and from Sleekburn 80,000 tons; and other districts adjoining, 160,000 tons—total 700,000 tons. The increase from the steam coal trade from the Tyne has been as follows:—1859, 1,275,707 tons; 1860, 1,647,091 tons; 1861, 1,544,067 tons; 1862, 1,955,586 tons. Besides the Low Main seam, there is another coal, called the Yard seam, which is capable of being worked in very large pieces, and combines in a great degree many of the excellencies peculiar to the Low Main seam. This seam is almost entire throughout the district, and there is sufficient left to endure, on the existing vend, for a period of sixty years. In addition to the Low Main and the Yard coal seams the following are met with, more or less, in the district on the north and south sides of the Tyne:—The Stone coal seam, Bersham seam, six-quarter seam, five-quarter seam, the Townley seam, and Walbottle seam; and to the north, some distance from the large downcast dyke of 90 fathoms, the High Main seam, stone coal seam, Bersham seam, gray seam, Plessy coal seam, and Beaumont seams. These seams are not now in operation, because, at the respective collieries, the Low Main and Yard seams are worked, as being more productive of profit. But there can be no doubt, as these are all workable seams, the time will arrive, as demand arises and coal becomes further enhanced in value, that they will come into operation. As regards the inferior description of coal, the time (one hundred and ten years) is so distant when the steam coal of the first quality will be exhausted, and as in addition the yard seam will endure sixty years, together one hundred and seventy years, Messrs. Foster and Taylor did not think it necessary to go into the question of quantity of inferior coal in reserve, excepting, generally, to remark that the various inferior seams of coal will naturally come into operation as those of superior quality are exhausted; at the northern part of Durham, adjoining the Tyne, throughout which those seams have been fully proved and explored, is very extensive, they do not anticipate that there will be any scarcity of coal in the Newcastle district for a very long time after the exhaustion of the steam coal seam.

Three men and a boy have been killed by foul air in an iron pit, at Cleator, Cumberland. It was the poor boy's first essay as a miner, and it is conjectured that the first man went into the drift for the purpose of getting a saw, and that, not returning, another man went in search of him, and afterwards a third, and, last of all, the boy. The deceased were found about 12 or 14 yards from the place where they were working. It further transpires that the first man went in without his lamp, as it was found hanging by the side of the pit.

The exports from the Tyne during the month include:—156,747 tons of coal; 11,173 tons of coke; and 75,841 cwts. of iron. Among the imports were: cargoes of pyrites from Levanger, Drontheim, Huelva, Antwerp, Pomaron, and Dordt; cargoes of manganese from Huelva, St. Lucar, Lalaja, and Rotterdam; 3,370 tons bar-iron from Gothenburg; 25,677 bars of lead from Carthagena; 3,956 tons of bar-iron from Norkoping; 200 tons of ironstone from Cherbourg; 2,744 bars of lead from Almeira; 170 tons of pig-iron from Corunna; seven cargoes of sulphur ore from Pomaron.

Yorkshire.—Reports of the iron trade are a little more favourable than they have been, for, although the Continental demand has fallen off, the home consumption is improving, and several furnaces have been put in blast

The Silkstone and South Yorkshire Coke Company has issued its prospectus. The capital has been fixed at 20,000*l.*, in shares of 5*l.* each. The object of the undertaking is to manufacture coke from the Silkstone and South Yorkshire coal for steel making, blast-furnaces, foundries, locomotives, and other purposes.

A company has just been formed, called "The Glazedale Smelting Company," for the purpose of building four blast-furnaces at Glazedale, in Danby, on the line of railway now making from Castleton to Grosmont, near Whitby. The capital is 40,000*l.*, in 400 shares, of 100*l.* each. The whole of the capital has been subscribed; one-half being held by two firms. Thirty acres of land at Glazedale-end have been purchased, and about two hundred acres adjoining have been leased. The property contains the Pecten and Avicular seams of ironstone, and a portion has the Top seam, so valuable for mixture. Operations are to be commenced when the railway is somewhat more advanced. It is reported that two other companies will be formed for erecting furnaces and smelting on the spot, the enormous quantities of ironstone abounding on the Castleton and Grosmont Railway. Limestones can be obtained about eighteen miles from the district.

## SCOTLAND.

Coals have been very dull of sale, and prices have shown a drooping tendency.

The pig-iron market has a little improved, but transactions have still been very limited. The following are the shipments for May as compared with the four first months of the year:—

| Month. | 1863. | 1862. | 1861. | 1860. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| January.. | 30,467 | 47,729 | 39,267 | 38,625 |
| February | 38,867 | 39,614 | 33,070 | 26,883 |
| March .. | 50,909 | 44,495 | 33,474 | 39,152 |
| April .. | 57,345 | 53,160 | 62,622 | 50,585 |
| Week ending May 2 .. | 13,650 | 13,815 | 14,734 | 13,273 |
| „ „ 9 .. | 16,329 | 14,127 | 16,045 | 16,015 |
| „ „ 16 .. | 12,360 | 14,121 | 18,110 | 13,600 |
| „ „ 23 .. | 14,444 | 13,972 | 16,748 | 11,600 |
| „ „ 30 .. | 11,037 | 14,426 | 16,399 | 12,213 |
| Total .. | 245,408 | 252,45 | 250,469 | 221,946 |

The shipments of the past month, it will be seen, were 67,820 tons, against 70,461 tons in May, 1862; 82,036 tons in May, 1861, and 66,701 tons in May, 1860. Matters have thus declined a little of late, but, on the whole, compare pretty well with the progressive activity of previous years. The home consumption continues good, and the only circumstance which keeps down prices is the largeness of the stock.

## FOREIGN AND COLONIAL.

France.—Accounts from the Haute Marne district are still depressed. The demand for iron at St. Dizier is confined to small lots, and there have scarcely been any operations sufficiently important to be noticed. Rolled irons are quoted at 9*l.* 4*s.* per ton first-class. The Moselle district is the only one in which the works are at all actively employed.

The following table shows the progress of the coal production of France during the last thirty years :—

| Year. | Total Tons. | Year. | Total Tons. |
|---|---|---|---|
| 1833 .. .. | 2,060,000 | 1848 .. .. | 4,000,000 |
| 1834 .. .. | 2,500,000 | 1849 .. .. | 4,050,000 |
| 1835 .. .. | 2,510,000 | 1850 .. .. | 4,430,000 |
| 1836 .. .. | 2,840,000 | 1851 .. .. | 4,480,000 |
| 1837 .. .. | 2,980,000 | 1852 .. .. | 4,900,000 |
| 1838 .. .. | 3,110,000 | 1853 .. .. | 5,940,000 |
| 1839 .. .. | 2,990,000 | 1854 .. .. | 6,830,000 |
| 1840 .. .. | 3,000,000 | 1855 .. .. | 7,450,000 |
| 1841 .. .. | 3,410,000 | 1856 .. .. | 7,925,000 |
| 1842 .. .. | 3,590,000 | 1857 .. .. | 7,900,000 |
| 1843 .. .. | 3,690,000 | 1858 .. .. | 7,350,000 |
| 1844 .. .. | 3,780,000 | 1859 .. .. | 7,480,000 |
| 1845 .. .. | 4,200,000 | 1860 .. .. | 8,300,000 |
| 1846 .. .. | 4,470,000 | 1861 .. .. | 8,400,000 |
| 1847 .. .. | 5,150,000 | 1862 .. .. | 9,400,000 |

Belgium.—It is said that another blast-furnace has been lighted at Forest, in the Charleroi district, at the works of Messrs. Mineur, Brother and Wilmot, for the production of casting pig. Merchants' iron has been very quiet and so little animation has prevailed that several works have lowered their prices.

Italy.—The Austrian Gazette announces that numerous veins of sulphur have just been discovered in the Island of Corfu.

Australia.—The Australian mail brought advices from the mining companies. At *Port Phillip*, the quantity of quartz crushed during March was 3,099 tons, yielding 1,993 ounces of gold. The receipts amounted to 3,338*l*., and the total payments were 1,827*l*., leaving a profit of 1,510*l*. The quantity of material crushed exceeds the previous month's return by about 13 tons per week; the yield had also improved to the extent of 1 dwt. 1 gr. per ton. The machinery was all in good working order.

At *Scottish Australian* the raising of ore from the stopes was being continued. They had sent off about 17½ tons of fine copper, and had on hand about 11 tons. All the works at the Lambton Colliery were being proceeded with as expeditiously as possible.

From *Fortune* (Western Australia) they report having dressed 20 tons of copper ore, and 20 tons of lead ore, 14 tons copper ore having been forwarded to Champion Bay.

Brazils.—From *Don Pedro North del Rey* the report states that the produce for April exceeded that for the preceding month. The works were progressing satisfactorily, both in the mine and on the surface, and the appearance of that part of the lode on which they were working was most encouraging.

United States.—From the *United States Railroad and Mining Register* we learn that seventeen anthracite furnaces were in blast in Schuylkill district during 1862, making 76,000 tons of iron. In the Lebanon Valley there were six furnaces in blast, making 30,000 tons of pig-iron. In the Lehigh district there were twenty-one furnaces in blast, making 175,948 tons of pig-iron. In the Susquehanna Valley there were twenty-six furnaces in blast, producing 94,000 tons of pig-iron. The Juniata and Cambria district had five furnaces in blast, producing 30,000 tons. These statistics show that the condition of the iron making districts of Pennsylvania has greatly improved during the past year, under the stimulus of a constant demand for iron at remunerative prices.

# Record of the Mining and Metal Markets.

## METALLIC-ORE MARKETS.

TIN.—The standards for black tin have again advanced, 3*l.* on all sorts, and are now—

| | | | |
|---|---|---|---|
| Superior Fine | .. £117 .... | Superior Common | .. £112 |
| Second Fine | .. 114 .... | Second Common | .. 111 |

It was at one time anticipated that the advance in the standards which took place in the middle of the month would have been quickly followed by another. Such, however, has not as yet been the case, but will doubtless soon take place.

COPPER.—At the four Cornish sales we give this month, the number of tons, average produce, quantity of fine copper, average price per ton, and standard have been as follows:—

| *Date.* | *Tons.* | *Produce.* | *Fine Copper.* Tons. cwt. | *Price per ton.* | *Standard.* |
|---|---|---|---|---|---|
| May 28. | 3,270 | 7 | 228 11 | £5 1 0 | £111 12 0 |
| June 4. | 3,224 | 6¾ | 217 0 | 5 1 6 | 116 3 0 |
| „ 11. | 2,233 | 7⅛ | 159 13 | 5 7 6 | 113 11 0 |
| „ 18. | 4,753 | 5⅞ | 276 14 | 4 4 6 | 119 11 0 |

At the sale of the 28th the standard advanced 18*s.* At the sale of the 4th it advanced 3*l.* At the sale of the 11th it declined 10*s.*; and at that of the 18th it declined 1*l.* 4*s.* according to the *West Briton*, but 2*l.* according to the *Mining Journal.*

LEAD.—Comparing this month's sales with those of last, we find that prices have, on an average, advanced about 10*s.* per ton.

## COAL MARKETS.

LONDON, *June* 28*th.*—From the returns of the Registrar of the London Coal Exchange, of the quantity of sea-borne Coal, Culm, and Cinders, imported into London in the month of May, we learn that the total quantity was 230,259 tons, against 282,287 tons during the corresponding month of last year, showing a *decrease* of 52,028 tons.

The following are the particulars of the 230,259 tons imported during May:—

| | | | | | |
|---|---|---|---|---|---|
| Newcastle | 78,499 tons, in 203 ships | | Scotland | 1,561 tons, in 11 ships | |
| Seaham | 21,362 „ 85 „ | | Wales | 9,780 „ 19 „ | |
| Sunderland | 65,169 „ 157 „ | | Yorkshire | 3,456 „ 27 „ | |
| Middlesbro'. | 4,665 „ 18 „ | | Small | 1,126 „ 2 „ | |
| Hartlepool | 42,280 „ 153 „ | | Cinders | 1,452 „ 9 „ | |
| Blyth | 903 „ 4 „ | | | | |

The quantity of coal imported by railways and canals during the month of May was 127,238 tons, against 106,214 tons during the corresponding month last year—showing an *increase* of 21,024 tons.

The London Coal Market has been on the whole tolerably active. On the 1st, the ships arrived were 46,—market dull. The prices were: Hetton Wallsend, 17*s.*; Braddyl's Wallsend, 15*s.* 3*d.*; Lambton Wallsend, 16*s.* 6*d.*; Eden Main, 14*s.* 6*d.*; Butes Tanfield Moor, 13*s.*; Tees Wallsend, 16*s.* 3*d.*; Stewart's Wallsend, 16*s.*; South Kelloe Wallsend, 14*s.*; Hasting's Hartley, 14*s.* 9*d.*; West Hartley, 15*s.* On the 3rd, new ships 8, market dull. On the 5th, new ships 13, market improved. On the 8th, new ships 33, prices advanced. On the 10th, new ships 50, market active for house coal, but dull for Hartley's. On the 12th, new ships 43, prices advanced. On the

**15th, new ships 54, market active. On the 17th, new ships 56, market firm. On the 19th, new ships 70, market dull, Hartley's reduced 3*d*.**

**On the 22nd, new ships 66, causing reduction of 6*d*. per ton. On the 24th, 78 new ships, market dull except for Hartley's which were a short supply. On the 26th, 33 new ships, market dull for house coals, but with a fair demand for Hartley's. The prices were: South Hetton Wallsend, 16*s*. 6*d*.; Haswell's Wallsend, 16*s*. 6*d*.; Eden Main, 14*s*. 6*d*.; South Kelloe Wallsend, 14*s*. 6*d*.; Heugh Hall Wallsend, 14*s*. 6*d*.; Gosforth Wallsend, 14*s*.; Harton Wallsend, 14*s*.; Kepier Grange Wallsend, 14*s*. 6*d*.; Davison's West Hartley, 15*s*.; Cowpen Hartley, 15*s*.; Bute's Tanfield, 13*s*.**

**LIVERPOOL.—From Messrs. J. and T. Platt's Coal Circular for June, we find that the quantity of coal, cannel, coke, and patent fuel shipped from Liverpool to foreign and colonial ports during the month of May was 31,134 tons, against 55,495 tons during the corresponding month of last year—showing a *decrease* of 24,361 tons. The total shipments from January to May were 210,377 tons, against 238,379 tons in the corresponding period last year—showing a *decrease* of 28,002 tons. The exports coastwise during May were 6,686 tons against 7,024 tons during the same month last year—showing an *increase* of 338 tons.**

**CONTRACTS.—The Admiralty require the supply of 9,000 tons of South Wales Coal, for Gibraltar; they also require 2,500 tons of South Wales Coal, for Ascension; 1,000 tons of South Wales Coal, for Valparaiso; and 700 tons of South Wales Coal, for the Piræus.**

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## SHARE MARKETS.

LONDON, *June 27th*.—The mining market has been again rather dull during the greater part of the past month, but towards the close there was a fair amount of business doing.

*East Caradon* still continues the main centre of attraction for market operations, and after a few fluctuations, shares have again ultimately declined, on the whole about 5*l*. per share. The opening price on the 1st was 31½*l*.-32*l*. They fluctuated between 31*l*. and 59*l*. until the 8th, when they were 28*l*.-29*l*. By the 11th they had receded to 25*l*.-26*l*., their lowest price. Since that date they have fluctuated between 26*l*. and 29*l*., closing at 28*l*.-28½*l*.

*Marke Valley* shares have been dull, and have receded a little in price. They opened 6½*l*.-6¾*l*., and close 6*l*.-6¼*l*. *West Caradon* shares, which opened at 24*l*.-25*l*., advanced at one time to 26*l*.-28*l*., but receded again, closing 24½*l*.-25*l*. *South Caradon*, 405*l*.-410*l*.

*East Basset* shares have steadily receded all through the month, and have, on the whole, declined about 30*l*. per share on our last price. They opened 110*l*.-115*l*., and gradually declined until the 12th, when they were quoted 86*l*.-88*l*. They recovered a little again to 90*l*.-92*l*. on the 13th, but immediately dropped again, and close at 81*l*.-83*l*. *Copper Hill*, 80*l*.-82*l*.

*North Basset* shares have declined slightly. They opened 3¾*l*.-4*l*., and close 3½*l*.-3¾*l*. *Wheal Buller*, 52½*l*.-57½*l*. *Wheal Basset*, 65*l*.-70*l*.

*Great Wheal Fortune* shares have been in request, and have slightly advanced. They opened 35½*l*.-36½*l*., and close 36*l*.-37*l*. *Wheal Sithney Carnmeal* shares have been in demand during the latter part of the month. They opened 5*l*.-5½*l*., and close 6*l*.-6½*l*. *Wendron Consols*, 11*l*.-12*l*. *Wheal Basset and Grylls* have declined from 24*l*.-26*l*. to 21*l*.-23*l*.

*Tincroft* shares have recovered last month's decline. They opened 19*l*.-19½*l*., and close 21*l*.-21½*l*. *North Roskear* shares have been little dealt in, and have again declined. They opened 28*l*.-30*l*., and close 23*l*.-25*l*. *Cook's Kitchen* shares dropped at one time 2*l*. per share on our last quotation,

but rallied again and close at a slight advance, 26*l.*-27*l.* *Stray Park* shares have been a good deal dealt in, but with little alteration in price, and close at 36*l.*-37*l.* *Wheal Harriett* shares have declined in price. They opened 3¾*l.*-4*l.*, and close 2¼*l.*-2¾*l.* *North Crofty*, 4*l.*-4½*l.* *Wheal Grenville* shares have advanced to 6¼*l.*-6½*l.*

*Wheal Seton* shares have dropped 30*l.* per share during the month. They opened 245*l.*-250*l.*, and fluctuated between 240*l.* and 247½*l.*, until the 11th, when they suddenly declined to 225*l.*-230*l.* They recovered again to 235*l.*-240*l.*, but again receded, closing at 210*l.*-220*l.* *East Carn Brea* shares have partially recovered last month's decline. They opened 7¼*l.*-7¾*l.*, and close 8*l.*-8½*l.* *South Frances*, 70*l.*-75*l.* *Clifford Amalgamated* have advanced upwards of 4*l.* per share. They opened 20*l.*-21*l.*, and remained at 21*l.*-22*l.* until the 23rd, when they sprang into demand and advanced to 24½*l.*-25½*l.*, at which they close. *West Tolgus* shares have advanced 10*l.* per share during the month. They opened 63*l.*-65*l.*, and close 73*l.*-75*l.* *South Tolgus*, 50*l.*-52*l.* *North Grambler*, 4*l.*-4½*l.*

*West Chiverton* shares have been in demand, and have advanced from 20¼*l.*-20¾*l.* to 22*l.*-23*l.* *Cargoll*, 40*l.*-41*l.* *Wheal Ludcott and Wrey* have steadily declined all through the month. They opened 5½*l.*-6*l.*, and close 4*l.*-4½*l.* *Wheal Mary Ann* shares have also receded. They opened 15½*l.*-16*l.*, but on the 20th they dropped as low as 11*l.*-12*l.*; they rallied again, however, and close 12½*l.*-13½*l.* *Wheal Trelawny*, 16½*l.*-17½*l.* *Herodsfoot* shares have dropped rather heavily. They opened 47*l.*-48*l.*, and have steadily declined all through the month, closing at 42*l.*-44*l.*

*Wheal Margaret* shares have advanced 3*l.* per share during the month. They opened 30*l.*-32*l.*, and close 34*l.*-35*l.* *Wheal Kitty* (St. Agnes), 7½*l.* *Wheal Kitty* (Lelant), 8¾*l.*-9*l.* *Providence*, 40*l.*-42*l.* *St. Ives Consols*, 26*l.*-28*l.*

*Wheal Crebor* shares have been dull, share receded in price. They opened 2⅜*l.*-2⅝*l.*, and close 1⅞*l.*-2⅛*l.* *Drakewalls* shares have declined from 2*l.*-2¼*l.* to 1⅝*l.*-1⅞*l.* Some transactions have been reported in *Bottle Hill* shares at 11*s.*-13*s.* *Wheal Edward*, 3*l.*-3¼*l.* *East Russell*, 4*l.*-4½*l.*

Transactions are also reported in the following mines:—*Wheal Grylls*, 30*l.*-31*l.* *Wheal Agar*, 3½*l.*-4*l.* *St. Day United*, 1*l.*-1⅛*l.* *East Rosewarne*, 2¾*l.*-3*l.* *Caradon and Phœnix*, 1⅛*l.*-1⅜*l.* *Glasgow Caradon*, 4*l.*-4½*l.* *Great South Tolgus*, 5*l.*-5½*l.* *New Wheal Martha*, 4*l.*-4½*l.* *North Dolcoath*, 2¼*l.*-2½*l.* *Wheal Unity*, 18*s.*-20*s.* *Hingston Down*, 2¾*l.*-3*l.* *North Robert*, 17*s.*-19*s.* *South Caradon*, *Wheal Hooper*, 13*s.*-15*s.* *North Downs*, 1⅞*l.*-2⅛*l.* *Carn Camborne*, 12*s.* 6*d.*-15*s.* *North Treskerby*, 3⅝*l.*-4*l.* *Gonamena*, 1¾*l.*-2*l.* *West Rose Down*, 6*l.*-8*l.* *North Buller*, 7½*l.*-8½*l.*

In Welsh mines *Bryn Gwiog* has been quoted at 30*l.*-31*l.* *Longrake*, 17*l.*-18*l.* *Central Minera*, 32*s.* 6*d.*-35*s.*

In colonial and foreign mines business has been done at the following prices:—*Cobre Copper*, 28*l.*-28½*l.* *Bon Accord*, ½*l.* *Cape Copper*, 2⅝*l.* *Don Pedro North Del Rey*, 1⅜*l.*-1½*l.* *Linares*, 7*l.* *Mariquita*, ½*l.*-¾*l.* *Port Phillip*, 1½*l.* *Alamillos*, ¾*l.*-⅞*l.* *Santa Barbara*, ⅝*l.* *Vallanzasca*, 1¼*l.*-1⅜*l.* *United Mexican*, 7⅛*l.*-7⅜*l.*

DUBLIN.—A very trifling amount of business has been transacted in the Irish mine share market during the past month, and that at reduced prices. *Wicklow Copper* shares have declined from 40*l.* 10*s.* to 37*l.* *Connorree*, 17*s.* *Carysfort*, 21*s.* 6*d.* *Mining Company of Ireland*, 19*l.* 10*s.*

CORNWALL.—A steady business has been done in the Cornish mine share market, the rise in the price of tin having given rise to a corresponding rise in the price of shares in tin mines. *South Crofty* shares have been little dealt in, and remain at 25*l.*-26*l.* *Wheal Emily Henrietta* shares have been in demand and have advanced to 10½*l.*-11*l.* *Condurrow* shares have declined to 105*l.*-110*l.* *West Tolgus* shares have advanced 12*l.* per share in

our last quotation. They opened 61*l*.-63*l*., and close 73*l*.-75*l*. *Wheal Reeth*, 40*l*. *Clijah and Wentworth*, 7½*l*.

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## METAL MARKETS.

LONDON, *June 27th*.—The metal market was quiet until the end of the month: prices, however, were all through firm, and at the close there has been a strong upward tendency. There is every prospect of a healthy trade coming on.

IRON.—The iron trade has been rather better, and prices have improved a little.

Scotch pig-iron has fluctuated between 50*s*. 6*d*. and 52*s*., closing firm at 52*s*.

Welsh bars have been in better request and prices have advanced to 5*l*. 15*s*. in Wales, 6*l*. 5*s*. f. o. b. in London. Staffordshire descriptions have been very firm, and makers well supplied with orders. Swedish bars have been quiet at 11*l*. 10*s*. to 11*l*. 15*s*.

STEEL.—The market for Swedish has been steady, but the demand has been so limited that sellers have been unable to obtain any increase on the present rates.

COPPER.—There has been a very good demand for raw at official prices, but there have been few sellers, and on the 26th there was an advance of 3*l*. on raw and manufactured.

Foreign has been much firmer, and prices have advanced. Burra Burra, 97*l*. Kapunda, 98*l*. Spanish, 89*l*. Chili, 85*l*.

YELLOW METAL.—This article has been in good steady request for shipment. Braziery sheets, 7½*d*. Sheathing, 8¼*d*.

TIN.—English has been firm and in good demand, and as the standards have advanced, a further rise in fixed rates is considered likely.

A good deal of business has been done in foreign. Straits, 126*l*. to 128*l*. Banca, 135*l*. The Banca annual sale took place on the 24th of this month. As the 20,000 slabs had arrived, which were afloat when the sale was announced, the number of slabs was increased to 119,200, the whole of which was disposed of at 76 florins, being 8¼ florins higher than last year, and 2⅝ florins in advance of the average of the last five years.

TIN PLATES.—This article has been firmer, and prices are likely to improve in consequence of the advance in the raw material.

LEAD.—This metal has only been in limited demand, though the market has been firm. Good soft English, 20*l*. 5*s*. to 20*l*. 12*s*. 6*d*.; W. B., 23*l*.

SPELTER.—The market for this metal was inactive in the early part of the month, but has improved at the close. On the spot 17*l*. 12*s*. 6*d*. to 17*l*. 15*s*.

GLASGOW, *June 18th*. IRON.—The pig-iron market has improved very much during the latter part of the month. Prices opened at 50*s*. 4½*d*., but gradually advanced to 52*s*., at which they close. The exports during June were 50,950 tons, against 47,922 tons during the corresponding period last year,—showing an *increase* of 47,922 tons.

LIVERPOOL, *June 20th*. COPPER.—Bolt and sheathing have been quoted at 96*l*. Tile, 89*l*. Best selected, 92*l*.

BERLIN, *June 20th*. IRON.—A good deal of Scotch pig-iron has been for sale, but found few purchasers. Iron in bars from 3⅝–4 Thlrs. Staffordshire, descriptions a little more in demand at 2 Thlrs.

TIN.—There has been more demand for this metal at advanced prices. Banca, 47½ Thlrs. English, 40½ Thlrs.

COPPER.—The demand for this article still continues trifling. Burra Burra, 33 Thlrs. Demidoff, 35 Thlrs.

HAMBURG, *June 18th.* COPPER.—This metal still keeps up its price, though the demand for it is small. Burra Burra and Kapunda 65 Mk. Lake superior, 65 to 68 Mk. English, best selected, 63 Mk. Tough cake, 61½ Mk.

TIN.—It being so soon after the Dutch sale, little more is bought. English is advancing, and a rise is daily expected.

AMSTERDAM, *June 20th.* TIN.—Banca is again at 79 fl., but business is very quiet.

HONG KONG, *April 29th.* IRON.—Nailrod, 2 dols. 60 c.; hoop, 3 dols. 20 c. to 3 dols. 50 c.; bar, 2 dols. 60 c. to 4 dols. Total sales, 2,080 piculs.

LEAD.—Sales about 2,800 piculs; 7 dols. 20 c. to 7 dols. 50 c.

NEW YORK, *June 3rd.* IRON.—There is a fair inquiry for both Scotch and American pig, and some 400 to 500 tons No. 1 brands of the former have been run off in lots at 33 dols. 50 c. to 34 dols. cash. Large parcels or invoices will not, of course, bring these prices, and 550 tons sold at something less.

*May 13th.* LEAD.—At Canton prices have further declined 10 c. Sales, 1,500 piculs. At Honkong prices unchanged. Sales, 50 pigs, at 7 dols. 20 c. to 7 dols. 50 c. At Macao, 300 pigs, W. B. mark, at 8 dols. 75 c. per picul.

IRON.—A better demand has existed. Quoted nailrod, 2 dols. 50 c. to 2 dols. 75 c.; hoop, 3 dols. 20 c. to 3 dols. 40 c.; bar, 2 dols. 60 c. to 4 dols. Sales of all kinds, 5,300 piculs.

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*Furnished by Von Dadelszen and North,* 158, *Leadenhall Street, London, E.C.*

The metal market has during the present month maintained considerable firmness, and in several instances higher prices prevail now at the close, although the business done has not been much above an average. Still the bright prospects so generally entertained with regard to the coming harvest, coupled with the comparative ease in the money market, encourage holders to wait for higher prices.

IRON.—Welsh bars are in better demand at 5*l.* 15*s.* f.o.b. in Wales with the usual difference f.o.b. here. Staffordshire is firmer. In Scotch pigs several fluctuations have taken place, and a rise of rather more than 1*s.* per ton has been established, closing firm at 52*s.* cash.

COPPER.—This market has gradually improved in tone, until on the 26th instant the smelters advanced the price both for raw and manufactured 3*l.* per ton; a rise was confidently looked for, as it was impossible to get on at fixed rate for some days before the advance took place. We quote tough cake and tile 92*l.* Best selected, 95*l.*, and manufactured, 99*l.* In foreign, Burra is 97*l.*; Kapunda, 98*l.*; Chili, 85*l.*

TIN.—There is a good demand for English at fixed quotations. In foreign there has been a considerable business done in Banca, both here and in Holland, at one time the price free on board there attained 80 f. per 50 kilos. The annual Dutch sale of Banca which took place on the 24th instant, went off at a lower figure than was generally anticipated, viz., all sold at 76 f. = 130*l.*, in warehouse here: some large parcels having changed hands at sale's price, the market has advanced rapidly to 78 f. @ 78½ f., at which it closes. Straits for the moment has been neglected, holders, however, are firm, and we quote cash parcels 126*l.* 10*s.* to 127*l.*

TIN PLATES. - In cokes an advance of 6*d.* per bin has taken place, which are in good demand. Charcoals are firm at old rates.

LEAD.—The market is steady, good soft English at from 20*l.* 5*s.* @ 20*l.* 12*s.* 6*d.*

SPELTER.—The market has improved during the past week, and spot parcels are now 17*l.* 12*s.* 6*d.* to 17*l.* 15*s.* according to brand, and 18*l.* for distant delivery.

# PRICES CURRENT OF METALS.

From Messrs. JAMES and SHAKSPEARE'S, 10, Austin Friars, E.C., 25*th June.*

| | | | | |
|---|---|---|---|---|
| | | | | Per Ton. |
| IRON | Bars (Welch) .. in Wales .. | —— | @ | £5 15 0 |
| | " " .. " Liverpool | £6 0 0 | " | 6 2 6 |
| | " " .. " London | 6 7 6 | " | 6 10 0 |
| | Nail Rods " .. " Wales . | —— | " | 6 0 0 |
| | " (Staffordshire) " Liverpool | 6 12 6 | " | 7 0 0 |
| | " " " London | 7 0 0 | " | 7 10 0 |
| | Hoops " " Liverpool | 7 15 0 | " | 8 2 6 |
| | " " " London | 8 5 0 | " | 8 10 0 |
| | Sheets " " Liverpool | 8 12 6 | " | 9 5 0 |
| | " " " London | 9 5 0 | " | 9 10 0 |
| | Bars " " Liverpool | 6 15 0 | " | 7 0 0 |
| | " " " London | 7 5 0 | " | 7 10 0 |
| | Scotch Pig (No. 1. g.m.b.) the Clyde | —— | " | 2 11 6 |
| | Rails ................ in Wales | 5 15 0 | " | 6 0 0 |
| | Swedish—Hammered—large sizes | —— | " | 11 10 0 |
| | " " Indian assortments | 11 10 0 | " | 11 15 0 |
| STEEL | Hammered—faggot ............ | 16 10 0 | " | 17 0 0 |
| | " in kegs (¼ and ⅜ in.) | 15 10 0 | " | 16 0 0 |
| COPPER, Australian | Burra and P.C.C. ............ | —— | " | 97 0 0 |
| | Kapunda .................. | —— | " | 97 0 0 |
| | Wallaroo .................. | —— | " | 96 0 0 |
| American | Baltimore .................. | —— | " | 96 0 0 |
| | Lake Superior .............. | —— | " | none |
| | Spanish Cake ................ | —— | " | 90 0 0 |
| | Chili and other Slab (for 96 per cent. pure Copper) ........ | —— | " | 86 0 0 |
| English | Tough Cake and Ingot and Tile | —— | " | 92 0 0 |
| | Best selected Ingot .......... | —— | " | 95 0 0 |
| | Sheets, Sheathing and Rod .... | —— | " | 99 0 0 |
| | Flat Bottoms ................ | —— | " | 104 0 0 |
| | | | | Per lb. |
| YELLOW METAL | Sheets .................... | 7¾*d.* | @ | 8*d.* |
| | Sheathing and Rod ........ | 8¼*d.* | " | 8½*d.* |
| | | | | Per Cwt. |
| TIN, English | Common Blocks and Ingots .... | —— | @ | 122*s.* |
| | " Bars (in barrels) ...... | —— | " | 123*s.* |
| | Refined .................... | —— | " | 128*s.* |
| Foreign | Straits, Fine .............. | —— | " | 127*s.* |
| | " (with 3 months' prompt) | —— | " | 129*s.* |
| | Banca .................... | 130*s.* 6*d.* | " | 131*s.* |
| | | | | Per Box. |
| TIN PLATES at Liverpool 6*d.* Less | Charcoal IC, best ............ | 28*s.* 6*d.* | @ | 29*s.* |
| | " IX " ............ | 34*s.* 6*d.* | " | 35*s.* |
| | Coke IC ................ | 22*s.* 6*d.* | " | 25*s.* |
| | " IX ................ | 28*s.* 6*d.* | " | 31*s.* |
| | | | | Per Ton. |
| LEAD, English | Sheet .................... | —— | @ | £21 0 0 |
| | Pig—W.B. .................. | —— | " | 22 15 0 |
| | " Other good brands ........ | 20 10 0 | " | 20 12 6 |
| | " German and Spanish, soft .. | —— | " | 20 5 0 |
| English | Red ...................... | —— | " | 21 15 0 |
| | Shot ...................... | —— | " | 23 10 0 |
| | Dry White .................. | —— | " | 26 0 0 |
| SPELTER | (Silesian) in Cakes ............ | —— | " | 17 12 6 |
| ZINC | (Sheet) No. 9 and upwards .... | —— | " | 23 5 0 |
| | | | | Per Bottle. |
| QUICKSILVER | (in bottles containing 75lbs. each) | —— | @ | 7 0 0 |
| | | | | Per Ton. |
| REGULUS OF ANTIMONY | French Star ...... | —— | @ | 40 0 0 |

# Tabular Abstract of Mining Accounts for the Month.

| Date of Account. | Name of Mine, and Number of Shares. | Balances. Debit. | Balances. Credit. | Calls. Per Share. | Calls. Total. | Dividends. Per Share. | Dividends. Total. |
|---|---|---|---|---|---|---|---|
| | **CORNISH AND DEVON MINES.** | £ s. d. | £ s. d. | £ s. d | £ s. d. | £ s. d. | £ s. d. |
| May 16 | East Chiverton (2,000) | 167 1 1 | — | 0 7 6 | 750 0 0 | — | — |
| „ 20 | Botallack (200) | — | 2,429 11 6 | — | — | 7 0 0 | 1,400 0 0 |
| „ 25 | Copper Hill (256) | — | 252 0 0 | — | — | — | — |
| „ 25 | Wheal Hearle (1,024) | 511 0 0 | — | 1 0 0 | 1,024 0 0 | — | — |
| „ 25 | North Buller (1,024) | 182 0 0 | — | 0 12 6 | 640 0 0 | — | — |
| „ 26 | East Basset (512) | — | 1,176 0 0 | — | — | 2 0 0 | 1,024 0 0 |
| „ 26 | South Tolgus (512) | — | 658 0 0 | — | — | 1 0 0 | 512 0 0 |
| „ 26 | South Caradon (512) | — | 4,456 7 4 | — | — | 4 0 0 | 2,048 0 0 |
| „ 26 | Drakewalls (12,800) | — | 1,322 1 0 | — | — | 0 1 6 | 960 0 0 |
| „ 26 | Wheal Harriett (5,120) | — | 2,033 7 11 | — | — | — | — |
| „ 26 | Great Work (119) | 642 6 9 | — | — | — | — | — |
| „ 27 | Polhigey Moor (6,000) | 707 2 0 | — | 0 3 0 | 900 0 0 | — | — |
| „ 27 | West Par (19,000) | 1,928 0 0 | — | 0 1 6 | 1,425 0 0 | — | — |
| „ 27 | Providence (1,120) | — | 1,919 5 1 | — | — | 1 5 0 | 1,400 0 0 |
| „ 28 | East Russell (4,000) | — | 422 7 3 | 0 5 0 | 1,000 0 0 | — | — |
| „ 28 | Craddock Moor (1,055) | — | 973 18 5 | — | — | — | — |
| „ 28 | Gonamena (6,144) | — | 374 17 4 | 0 2 6 | 768 0 0 | — | — |
| „ 28 | Wheal Prosper (970) | 414 0 1 | — | 0 15 0 | 726 15 0 | — | — |
| „ 29 | Garden (114) | 160 8 3 | — | 4 0 0 | 456 0 0 | — | — |
| June 1 | Spearne Consols (794) | 293 13 8 | — | — | — | — | — |
| „ 1 | East Rosewarne (5,000) | — | 183 0 0 | — | — | — | — |
| „ 2 | Herodsfoot (1,024) | — | 2,278 16 2 | — | — | 1 15 0 | 1,792 0 0 |
| „ 3 | Trelyon Consols (572) | 340 5 7 | — | — | — | — | — |
| „ 3 | North Levant (2,000) | 438 19 0 | — | 0 3 0 | 300 0 0 | — | — |
| „ 3 | West Sharp Tor (256) | 53 9 11 | — | 3 0 0 | — | — | — |
| „ 4 | Sortridge Consols (12,000) | — | — | 0 3 0 | 1,800 0 0 | — | — |
| „ 5 | Goonzion (2,000) | 447 5 0 | — | 0 5 0 | 500 0 0 | — | — |
| „ 5 | Wheal Tremayne (1,022) | — | 76 13 10 | — | — | — | — |
| „ 6 | Pedn-an-drea (8,465) | 992 5 2 | — | 0 3 0 | 1,269 15 0 | — | — |
| „ 8 | Tincroft (6,000) Bonus | — | — | — | — | 0 10 0 | 3,000 0 0 |
| „ 8 | Dolcoath (358) | — | 3,697 9 1 | — | — | 8 0 0 | 2,864 0 0 |
| „ 8 | Wheal Seton (396) | — | 2,134 15 10 | — | — | 3 0 0 | 1,188 0 0 |
| „ 9 | Boscaswell (1,248) | — | 612 15 4 | — | — | 0 5 0 | 312 0 0 |
| „ 9 | North Treskerby (5,936) | — | 830 4 9 | — | — | 0 1 6 | 445 4 0 |
| „ 9 | Wheal Mary Ann (1,024) | — | 2,242 6 4 | — | — | — | — |
| „ 9 | Worvas Downs (944) | 729 13 5 | — | 1 0 0 | 944 0 0 | — | — |
| „ 10 | Condurrow (256) | 1,101 0 0 | — | — | — | — | — |
| „ 11 | Wheal Trelawny (1,040) | — | 935 19 1 | — | — | 0 10 0 | 520 0 0 |
| „ 11 | Wheal Norris (6,000) | 1,221 15 6 | — | 0 4 0 | 1,200 0 0 | — | — |
| „ 12 | Spearne Moor (280) | 334 19 3 | — | — | — | — | — |
| „ 15 | South Crofty (937) | 583 1 6 | — | 1 0 0 | 937 0 0 | — | — |
| „ 16 | West Seton (400) | — | 3,173 13 7 | — | — | 5 0 0 | 2,000 0 0 |
| „ 16 | Boscean (240) | — | 398 19 8 | — | — | — | — |
| „ 16 | West Trevelyan (5,481) | 676 5 11 | — | 0 2 6 | 685 2 6 | — | — |
| „ 16 | East Falmouth (2,048) | — | 29 9 7 | 0 5 0 | 512 0 0 | — | — |
| „ 17 | Great Wheal Vor (5,908) | — | 2,954 12 5 | — | — | — | — |
| „ 17 | Caradon Consols (914) | 131 16 3 | — | 0 15 0 | 685 10 0 | — | — |
| „ 17 | Great Caradon (4,096) | 24 0 0 | — | 0 2 0 | 409 12 0 | — | — |
| „ 17 | Wheal Reeth (240) | — | 300 0 0 | — | — | — | — |
| „ 17 | Camborne Consols (1,000) | 273 11 8 | — | 0 5 0 | 250 0 0 | — | — |
| „ 18 | Gawton (4,000) | — | 55 9 7 | 0 5 0 | 1,000 0 0 | — | — |
| „ 19 | Tamar (9,600) | — | 1,511 0 0 | — | — | — | — |
| | **WELSH MINE.** | | | | | | |
| June 11 | South Foxdale (5,000) | — | 300 0 0 | — | — | — | — |
| | **FOREIGN MINES.** | | | | | | |
| June 18 | Linares (15,000) | — | — | — | — | 0 5 0 | 3,750 0 0 |
| „ 19 | St. John Del Rey (11,000) | — | 45,002 17 4 | — | — | 3 10 0 | 38,500 0 0 |

# Copper Ores.

**Sampled May 13, and sold at the Royal Hotel, Truro, May 28.**

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| South Cara lon ......... | 80 | 7, 9 | £6 | 11 | 6 |
| | 63 | 7, 8 | 4 | 9 | 6 |
| | 60 | 1, 6 | 8 | 15 | 0 |
| | 59 | 1, 2, 6, 9 | 8 | 4 | 6 |
| | 57 | 1, 6 | 16 | 2 | 6 |
| | 53 | 1, 6 | 12 | 16 | 6 |
| | 46 | 8, 14 | 5 | 8 | 0 |
| | 36 | 10 | 1 | 18 | 6 |
| | 30 | 10 | 5 | 19 | 6 |
| West Caradon ......... | 75 | 14 | 7 | 9 | 0 |
| | 71 | 9 | 5 | 18 | 0 |
| | 63 | 2 | 5 | 6 | 0 |
| | 62 | 5 | 8 | 5 | 0 |
| | 61 | 9 | 5 | 5 | 0 |
| | 37 | 1 | 9 | 15 | 6 |
| | 36 | 6 | 5 | 15 | 6 |
| | 34 | 12 | 3 | 19 | 6 |
| | 27 | 1 | 1 | 5 | 6 |
| Great Wheal Busy ... | 73 | 5, 7 | 2 | 3 | 6 |
| | 69 | 2, 7, 9, 13 | 3 | 0 | 6 |
| | 66 | 7 | 1 | 14 | 6 |
| | 48 | 5, 9 | 3 | 1 | 6 |
| | 43 | 5, 10 | 2 | 5 | 6 |
| | 41 | 5, 10 | 2 | 3 | 6 |
| | 40 | 5 | 2 | 10 | 0 |
| | 37 | 5, 10 | 1 | 12 | 6 |
| | 24 | 11 | 5 | 7 | 6 |
| North Treskerby ...... | 68 | 6 | 4 | 1 | 6 |
| | 65 | 3 | 4 | 3 | 6 |
| | 58 | 3 | 5 | 4 | 6 |
| | 57 | 3, 5, 10 | 3 | 15 | 0 |
| | 56 | 9 | 3 | 8 | 6 |
| | 55 | 3 | 5 | 12 | 6 |
| | 48 | 5, 7 | 4 | 0 | 0 |
| Clifford Amalgamated | 75 | 11 | 4 | 5 | 0 |
| | 53 | 3 | 3 | 15 | 0 |

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| Clifford Amalgamated | 48 | 5 | £5 | 3 | 0 |
| | 43 | 5 | 1 | 6 | 0 |
| | 38 | 5 | 4 | 8 | 0 |
| | 37 | 3, 5 | 3 | 0 | 0 |
| | 20 | 1 | 0 | 17 | 6 |
| | 18 | 5 | 2 | 16 | 6 |
| Fowey Consols ......... | 85 | 6 | 5 | 10 | 6 |
| | 82 | 1 | 6 | 10 | 6 |
| | 60 | 1 | 1 | 5 | 6 |
| | 53 | 10 | 5 | 6 | 0 |
| | 48 | 10 | 4 | 12 | 0 |
| Wheal Polmear......... | 64 | 7 | 3 | 9 | 6 |
| | 51 | 7 | 5 | 2 | 0 |
| | 50 | 1, 5 | 8 | 17 | 6 |
| | 36 | 2 | 3 | 15 | 0 |
| North Downs ......... | 56 | 3 | 5 | 0 | 6 |
| | 54 | 3 | 6 | 1 | 0 |
| | 46 | 3 | 7 | 15 | 0 |
| | 42 | 14 | 4 | 7 | 6 |
| Craddock Moor......... | 63 | 6 | 4 | 18 | 6 |
| | 58 | 6 | 6 | 8 | 0 |
| | 38 | 2, 6 | 5 | 1 | 0 |
| St. Day United......... | 40 | 13 | 4 | 14 | 0 |
| | 31 | 10, 12 | 2 | 7 | 6 |
| | 28 | 10 | 1 | 10 | 6 |
| | 1 | 8 | 12 | 7 | 6 |
| South Crinnis ......... | 52 | 13 | 4 | 1 | 6 |
| Burra Burra ............ | 35 | 7 | 3 | 6 | 6 |
| Tredinnick's Ore ...... | 19 | 5 | 0 | 11 | 0 |
| | 16 | 5 | 0 | 18 | 0 |
| Wheal Damsel ......... | 14 | 12 | 2 | 14 | 6 |
| | 4 | 12 | 5 | 12 | 6 |
| North Phœnix ......... | 7 | 1 | 4 | 10 | 0 |
| Barrett's Ore............ | 5 | 1 | 41 | 0 | 0 |
| Aver's Ore............... | 2 | 1 | 28 | 10 | 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| South Caradon ............... | 484 | £3,914 | 0 | 0 |
| West Caradon................. | 466 | 2,882 | 9 | 0 |
| Great Wheal Busy..... ...... | 441 | 1,105 | 1 | 6 |
| North Treskerby ............ | 407 | 1,758 | 9 | 0 |
| Clifford Amalgamated ...... | 332 | 1,167 | 3 | 6 |
| Fowey Consols ............... | 328 | 1,582 | 17 | 6 |
| Wheal Polmear ............... | 201 | 1,061 | 5 | 0 |
| North Downs .................. | 198 | 1,148 | 7 | 0 |
| Craddock Moor ............... | 159 | 873 | 7 | 6 |
| St. Day United ............... | 100 | £316 | 14 | 0 |
| South Crinnis................. | 52 | 211 | 18 | 0 |
| Burra Burra .................. | 35 | 116 | 7 | 6 |
| Tredinnick's Ore ............ | 35 | 24 | 17 | 0 |
| Wheal Damsel ............... | 18 | 60 | 13 | 0 |
| North Phœnix ................ | 7 | 31 | 10 | 0 |
| Barratt's Ore ................. | 5 | 205 | 0 | 0 |
| Aver's Ore ..................... | 2 | 57 | 0 | 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| 1 Vivian and Sons ....... .. | 364½ | £2,723 | 15 | 5 |
| 2 Freeman and Co. ...... | 150 | 738 | 7 | 0 |
| 3 Grenfell and Sons ...... | 424½ | 2,173 | 18 | 0 |
| 4 Crown Copper Co. ...... | — | —— | | |
| 5 Sims, Willyams & Co.... | 491½ | 1,878 | 17 | 6 |
| 6 Williams, Foster & Co. | 428½ | 2,915 | 5 | 10 |
| 7 Mason and Elkington... | 365½ | 1,344 | 5 | 1 |
| 8 Bankart and Sons ...... | 55½ | 277 | 10 | 9 |
| 9 Copper Miners' Co. ... | 284 | £1,441 | 5 | 0 |
| 10 Charles Lambert ...... | 290 | 1,024 | 11 | 6 |
| 11 Newton, Keates & Co. | 99 | 447 | 15 | 0 |
| 12 Sweetland, Tuttle & Co. | 67½ | 232 | 12 | 3 |
| 13 Neath Copper Co. ...... | 109½ | 452 | 1 | 8 |
| 14 Penclawdd Copper Co. | 140 | 866 | 14 | 0 |
| Total ........... | 3,270 | £16,516 | 19 | 0 |

Average Produce, 7.
Quantity of Fine Copper, 228 tons 11 cwts.

Average Standard ..................£111 12 0
Average price per ton ............ 5 1 0

# Copper Ores.

**Sampled May 20, and sold at Tyack's Hotel, Camborne, June 4.**

| Mines. | Tons. | Purchasers. | Price. | Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|---|---|---|---|
| Clifford Amalgamated | 101 | 1, 6 | £6 10 6 | East Pool ............... | 70 | 1 | £0 12 6 |
| | 95 | 1, 6 | 6 15 6 | | 46 | 2 | 3 10 6 |
| | 85 | 1, 6 | 7 1 6 | | 45 | 9 | 2 19 0 |
| | 84 | 5 | 4 13 6 | | 39 | 6, 10, 12 | 3 8 6 |
| | 82 | 2 | 3 13 0 | South Frances ......... | 67 | 1 | 5 11 6 |
| | 67 | 2, 6 | 6 6 6 | | 60 | 6 | 5 9 0 |
| | 60 | 6, 10 | 3 13 6 | | 56 | 1 | 7 1 6 |
| | 59 | 5 | 5 13 0 | | 26 | 6 | 5 12 0 |
| | 58 | 12 | 3 8 0 | | 5 | 3, 12 | 3 13 6 |
| | 56 | 7 | 3 14 6 | Wheal Basset ......... | 52 | 5, 10 | 4 12 0 |
| | 48 | 11 | 3 19 6 | | 50 | 10 | 5 8 6 |
| | 47 | 5 | 6 13 6 | | 43 | 7 | 6 7 0 |
| | 25 | 10 | 4 14 6 | | 27 | 9 | 6 0 0 |
| | 18 | 7 | 2 12 6 | Tincroft .................. | 64 | 12 | 2 0 6 |
| (Consols) | 77 | 5 | 5 19 0 | | 53 | 3 | 4 19 0 |
| West Seton ............ | 99 | 7, 9 | 2 11 0 | | 13 | 10 | 1 10 0 |
| | 92 | 13 | 6 5 6 | South Tolgus ......... | 78 | 3, 6 | 3 6 6 |
| | 76 | 7 | 5 3 0 | | 52 | 9 | 5 13 0 |
| | 70 | 11 | 4 11 6 | Dolcoath ............... | 47 | 7 | 5 9 0 |
| | 62 | 9 | 4 19 6 | | 35 | 3, 7 | 3 13 0 |
| | 56 | 3 | 6 12 0 | | 31 | 3 | 6 0 6 |
| | 51 | 7 | 7 8 6 | East Basset ............ | 41 | 2, 13 | 6 3 6 |
| | 44 | 7 | 6 1 6 | | 39 | 1, 5 | 5 11 6 |
| | 29 | 8, 14 | 6 4 6 | | 27 | 3 | 11 3 6 |
| Wheal Seton ............ | 28 | 3 | 4 8 6 | Stray Park............... | 54 | 6 | 3 19 0 |
| (Pendarves) | 87 | 10 | 1 2 0 | North Roskear ......... | 39 | 5 | 8 3 0 |
| | 85 | 13 | 6 1 6 | Camborne Vean ...... | 35 | 7 | 5 4 0 |
| | 83 | 7 | 5 15 0 | Condurrow.............. | 33 | 6 | 4 11 0 |
| | 56 | 9, 11 | 5 4 0 | Crane ..................... | 5 | 1 | 10 14 6 |
| | 35 | 1, 5 | 13 5 0 | | 2 | 1 | 6 0 6 |
| East Pool ............... | 75 | 9 | 4 0 0 | | | | |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | Tons. | Amount |
|---|---|---|---|---|---|
| Clifford Amalgamated...... | 962 | £5,107 10 0 | Dolcoath ........................ | 113 | £570 13 6 |
| West Seton...................... | 579 | 3,045 19 0 | East Basset ...................... | 107 | 772 6 6 |
| Wheal Seton .................. | 374 | 1,968 3 6 | Stray Park ....................... | 54 | 213 6 0 |
| East Pool ...................... | 275 | 772 4 6 | North Roskear ................ | 39 | 317 17 0 |
| South Frances ............... | 214 | 1,260 14 0 | Camborne Vean ............. | 35 | 182 0 0 |
| Wheal Basset.................. | 172 | 945 10 0 | Condurrow ...................... | 33 | 150 3 0 |
| Tincroft ......................... | 130 | 411 9 0 | Crane ............................. | 7 | 65 13 6 |
| South Tolgus .................. | 130 | 553 3 0 | | | |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Vivian and Sons ......... | 377½ | £2,171 15 0 | 9 Copper Miners' Co. ...... | 338½ | £1,468 16 6 |
| 2 Freeman and Co.......... | 182 | 799 18 6 | 10 Charles Lambert ......... | 244 | 778 19 0 |
| 3 Grenfell and Sons ...... | 251½ | 1,437 18 0 | 11 Newton, Keates & Co. ... | 146 | 656 13 0 |
| 4 Crown Copper Co. ...... | — | —— | 12 Sweetland, Tuttle & Co. | 137½ | 380 10 3 |
| 5 Sims, Willyams & Co. | 369 | 2,275 19 3 | 13 Neath Copper Co. ...... | 187½ | 1,220 5 3 |
| 6 Williams, Foster & Co. | 429 | 2,284 8 0 | 14 Penclawdd Copper Co. | 14½ | 90 5 3 |
| 7 Mason and Elkington ... | 520 | 2,671 15 6 | | | |
| 8 Bankart and Sons ...... | 17 | 99 9 0 | Total ............... | 3,224 | £16,336 12 6 |

Average Produce, 6¾.
Quantity of Fine Copper, 217 tons 0 cwts.

Average Standard ..................£116 3 0
Average Price per ton ........... 5 1 6

# Copper Ores.

**Sampled May 27, and sold at Tabb's Hotel, Redruth, June 11.**

| Mines. | Tons. | Purchasers. | Price. | Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|---|---|---|---|
| West Basset ............ | 70 | 6 | £5 2 6 | Treloweth ............... | 71 | 8 | £3 19 6 |
| | 69 | 5 | 4 12 0 | | 26 | 7 | 11 1 0 |
| | 66 | 12 | 3 4 6 | | 18 | 8 | 5 14 6 |
| | 63 | 14 | 4 0 0 | Pendeen Consols ...... | 59 | 12 | 2 11 6 |
| | 59 | 7 | 4 18 6 | | 35 | 5 | 2 11 0 |
| | 43 | 2 | 5 13 6 | | 10 | 12 | 3 12 6 |
| | 42 | 3, 5 | 11 14 6 | East Carn Brea......... | 35 | 6 | 4 8 6 |
| | 36 | 12 | 3 6 6 | | 34 | 13, 14 | 4 10 0 |
| | 34 | 10 | 3 4 6 | | 32 | 1, 3 | 7 9 6 |
| Carn Brea ............... | 73 | 5, 7 | 7 6 0 | Rosewarne Consols ... | 42 | 1 | 10 1 0 |
| | 69 | 10, 13 | 3 2 0 | | 28 | 1, 3 | 5 5 6 |
| | 57 | 2, 6 | 3 0 6 | | 27 | 1, 3, 7 | 5 14 6 |
| | 46 | 7 | 3 17 6 | Copper Hill ............ | 54 | 7 | 1 14 0 |
| Par Consols ............ | 82 | 9 | 7 0 6 | | 34 | 3 | 7 16 0 |
| | 77 | 2, 6 | 7 0 0 | Wheal Uny ............ | 40 | 13 | 4 16 6 |
| | 58 | 10 | 3 10 0 | | 28 | 13 | 6 13 6 |
| Prosper United......... | 56 | 5 | 3 9 6 | Wheal Buller............ | 51 | 9 | 2 14 6 |
| | 52 | 7 | 3 15 6 | | 10 | 1 | 15 8 6 |
| | 50 | 7, 12 | 2 8 6 | Wheal Anna ............ | 54 | 5 | 5 9 6 |
| | 28 | 5 | 4 16 6 | Nanjiles .................. | 28 | 12 | 5 18 6 |
| Great South Tolgus... | 59 | 6, 7 | 9 5 6 | Great Wheal Alfred... | 25 | 7 | 2 12 0 |
| | 49 | 3 | 9 9 6 | New Rosewarne ...... | 20 | 7 | 7 6 0 |
| | 42 | 3, 5, 7 | 10 4 6 | Camborne Consols ... | 16 | 3, 13 | 7 1 6 |
| | 32 | 2 | 4 16 0 | Rosewarne United ... | 15 | 7 | 3 13 6 |
| West Fowey Consols | 66 | 5 | 5 15 0 | South Dolcoath......... | 7 | 13 | 11 1 0 |
| | 56 | 1 | 6 16 6 | | | | |

TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| West Basset .................. | 482 | £2,398 8 0 | Copper Hill ..................... | 88 | £357 0 0 |
| Carn Brea ...................... | 245 | 1,097 9 6 | Wheal Uny ..................... | 68 | 379 18 0 |
| Par Consols .................. | 217 | 1,318 1 0 | Wheal Buller .................. | 61 | 293 4 6 |
| Prosper United ............... | 186 | 647 5 0 | Wheal Anna .................. | 54 | 295 13 0 |
| Great South Tolgus ......... | 182 | 1,594 11 0 | Nanjiles ........................ | 28 | 165 18 0 |
| West Fowey Consols ...... | 122 | 761 14 0 | Great Alfred .................. | 25 | 65 0 0 |
| Treloweth ...................... | 115 | 672 11 6 | New Rosewarne ............... | 20 | 146 0 0 |
| Pendeen Consols ............ | 104 | 277 8 6 | Camborne Consols............ | 16 | 113 4 0 |
| East Carn Brea............... | 101 | 547 1 6 | Rosewarne United............ | 15 | 55 2 6 |
| Rosewarne Consols ........ | 97 | 724 7 6 | South Dolcoath ............... | 7 | 77 7 0 |

EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Vivian and Sons ............ | 147 | £1,203 10 6 | 9 Copper Miners' Co. ... | 133 | 715 0 6 |
| 2 Freeman and Co. ......... | 142 | 753 6 9 | 10 Charles Lambert......... | 126½ | 419 12 0 |
| 3 Grenfell and Sons ......... | 165 | 1,420 8 6 | 11 Newton, Keates & Co. | — | —— |
| 4 Crown Copper Co. ......... | — | —— | 12 Sweetland, Tuttle & Co. | 224 | 747 5 0 |
| 5 Sims, Willyams & Co. ... | 379½ | 2,067 6 6 | 13 Neath Copper Co. ...... | 184½ | 697 6 0 |
| 6 Williams, Foster & Co. ... | 201½ | 1,142 19 0 | 14 Penclawdd Co............. | 80 | 328 10 0 |
| 7 Mason and Elkington ... | 411 | 2,105 14 3 | | | |
| 8 Bankart and Sons ... ..... | 89 | 385 5 6 | Total............... | 2,233 | £11,986 4 6 |

Average Produce, 7½.
Quantity of Fine Copper, 159 tons 13 cwts.

Average Standard .................. £113 11 0
Average Price per ton ........... 5 7 3

# Copper Ores.

Sampled June 3, and sold at the Royal Hotel, Truro, June 18.

| Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|
| Devon Great Consols... | 139 | 13 | £4 14 6 |
| | 132 | 6 | 4 10 0 |
| | 131 | 6 | 4 7 6 |
| | 130 | 3 | 5 4 0 |
| | 121 | 2 | 4 15 0 |
| | 119 | 6, 11, 12 | 4 1 6 |
| | 113 | 5 | 5 11 0 |
| | 111 | 7 | 5 2 6 |
| | 109 | 10 | 3 1 0 |
| | 108 | 1, 5 | 9 1 6 |
| | 103 | 9 | 5 3 6 |
| | 101 | 7 | 5 16 0 |
| | 97 | 1 | 1 19 6 |
| | 96 | 9 | 4 16 6 |
| | 95 | 12 | 4 0 6 |
| | 93 | 14 | 5 8 0 |
| | 90 | 1, 10 | 1 18 0 |
| | 63 | 14 | 3 19 6 |
| | 60 | 11 | 4 2 6 |
| | 51 | 1 | 1 18 0 |
| | 38 | 8 | 4 10 6 |
| Phœnix Mines ......... | 102 | 8 | 2 1 6 |
| | 94 | 7 | 3 4 0 |
| | 84 | 7 | 3 4 0 |
| | 66 | 8 | 2 6 0 |
| | 65 | 3 | 5 18 0 |
| | 53 | 5, 8 | 3 0 0 |
| East Caradon ... ........ | 89 | 1 | 3 10 0 |
| | 71 | 1, 10 | 3 7 6 |
| | 65 | 1, 6 | 4 1 6 |
| | 60 | 10 | 3 5 0 |
| | 49 | 1 | 7 15 6 |
| | 54 | 5 | 6 3 0 |
| East Caradon ............ | 51 | 1 | £6 8 6 |
| Marke Valley ............ | 85 | 8 | 3 5 6 |
| | 83 | 1, 8 | 3 7 6 |
| | 82 | 8 | 3 10 0 |
| | 81 | 3, 8 | 3 14 6 |
| | 51 | 10 | 2 4 0 |
| | 28 | 10 | 1 17 6 |
| Devon and Cornwall... | 95 | 6, 10 | 1 8 6 |
| | 88 | 10 | 1 8 6 |
| | 71 | 3 | 2 6 0 |
| | 36 | 3 | 5 13 6 |
| Bedford United ......... | 111 | 6 | 3 10 6 |
| | 93 | 2 | 5 10 0 |
| Crelake..................... | 67 | 13 | 5 15 0 |
| | 60 | 9 | 3 15 0 |
| | 48 | 9 | 2 8 6 |
| Wheal Emma ............ | 57 | 12 | 3 14 6 |
| | 46 | 5 | 1 12 0 |
| | 30 | 9 | 6 12 6 |
| North Wheal Robert ... | 56 | 1 | 0 13 6 |
| | 55 | 5 | 6 0 6 |
| Wheal Friendship ...... | 51 | 1 | 10 10 0 |
| | 50 | 5 | 6 3 0 |
| Brookwood ............... | 60 | 10 | 3 6 6 |
| | 21 | 6 | 5 12 6 |
| | 11 | 8 | 9 3 6 |
| Wheal Arthur ......... | 48 | 6 | 2 10 6 |
| | 30 | 6, 9 | 5 7 6 |
| Gunnis Lake (Clitters) | 52 | 7, 8 | 4 18 0 |
| Sortridge Consols ...... | 22 | 7 | 7 15 6 |
| | 17 | 7 | 4 6 6 |
| Hawkmoor ............... | 35 | 3, 9 | 5 2 6 |
| Fursdon .................. | 19 | 6 | 4 9 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. |
|---|---|---|
| Devon Great Consols... | 2,100 | £9,664 2 0 |
| Phœnix Mines............ | 464 | 1,475 11 0 |
| East Caradon ............ | 450 | 2,135 13 0 |
| Marke Valley ............ | 410 | 1,311 18 6 |
| Devon and Cornwall ... | 290 | 628 7 6 |
| Bedford United ......... | 204 | 902 15 6 |
| Crelake...................... | 175 | 726 13 0 |
| Wheal Emma ............ | 138 | 484 13 6 |
| North Wheal Robert ......... | 111 | £369 3 6 |
| Wheal Friendship ............ | 101 | 843 0 0 |
| Brookwood ...................... | 92 | 418 11 0 |
| Wheal Arthur.................... | 78 | 282 9 0 |
| Gunnis Lake ..................... | 52 | 254 16 0 |
| Sortridge Consols ............ | 39 | 244 11 6 |
| Hawkmoor ...................... | 35 | 179 7 6 |
| Fursdon ......................... | 19 | 84 11 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. |
|---|---|---|
| 1 Vivian and Sons ......... | 727½ | £3,311 0 9 |
| 2 Freeman and Co. ......... | 214 | 1,086 5 0 |
| 3 Grenfell and Sons ......... | 335½ | 1,435 0 3 |
| 4 Crown Copper Co.......... | — | —— |
| 5 Sims, Willyams & Co. ... | 399½ | 2,247 8 6 |
| 6 Williams, Foster & Co. ... | 596½ | 2,324 13 4 |
| 7 Mason and Elkington ... | 455 | 2,096 5 0 |
| 8 Bankart and Sons ......... | 478 | 1,548 13 3 |
| 9 Copper Miners' Co. ...... | 369½ | £1,706 13 9 |
| 10 Charles Lambert ......... | 524 | 1,290 1 0 |
| 11 Newton, Keates & Co.... | 99½ | 409 2 10 |
| 12 Sweetland, Tuttle & Co. | 191½ | 756 6 10 |
| 13 Neath Copper Co. ...... | 206 | 1,042 0 6 |
| 14 Penclawdd Co............. | 156 | 752 12 6 |
| Total ............... | 4,753 | £20,006 3 6 |

Average Produce, 5¾.
Quantity of Fine Copper, 276 tons 14 cwts.

Average standard ..................£119 11 0
Average Price per ton ............ 4 4 6

# Copper Ores.

Sampled May 6, and sold at Swansea, May 26.

| Mines. | Tons. | Produce. | Purchasers. | Price. £ | s. | d. |
|---|---|---|---|---|---|---|
| Berehaven ...... | 127 | 10¾ | 3 | £8 | 6 | 0 |
| | 119 | 10⅝ | 5 7 | 8 | 1 | 0 |
| | 100 | 10¾ | 3 | 8 | 6 | 0 |
| | 95 | 10¼ | 7, 15 | 8 | 1 | 6 |
| | 110 | 10⅞ | 13 | 8 | 7 | 0 |
| | 63 | 10¾ | 2 | 8 | 5 | 0 |
| | 104 | 10⅛ | 7 | 8 | 2 | 0 |
| Chili .............. | 48 | 15⅞ | 10 | 12 | 7 | 6 |
| | 55 | 16⅛ | 5 | 12 | 16 | 0 |
| | 54 | 15⅝ | 1 | 11 | 18 | 0 |
| | 53 | 17¼ | 9 | 13 | 5 | 6 |
| | 52 | 17¾ | 3, 6 | 13 | 8 | 0 |
| | 51 | 16¾ | 9 | 12 | 18 | 0 |
| | 50 | 17⅞ | 8 | 13 | 18 | 0 |
| | 49 | 17⅝ | 3 | 13 | 13 | 0 |
| | 48 | 17⅛ | 3 | 13 | 5 | 0 |
| | 47 | 17⅜ | 6 | 13 | 12 | 0 |
| | 46 | 17⅜ | 10 | 13 | 17 | 6 |
| | 45 | 18 | 6 | 14 | 1 | 0 |
| | 65 | 18½ | 6 | 14 | 5 | 0 |
| Cobre .............. | 87 | 13¼ | 11 | 10 | 3 | 0 |
| | 86 | 13⅝ | 7, 11 | 10 | 2 | 6 |

| Mines. | Tons. | Produce. | Purchasers. | Price. £ | s. | d. |
|---|---|---|---|---|---|---|
| Cobre .............. | 85 | 13⅝ | 11, 15 | £10 | 3 | 0 |
| | 75 | 13½ | 11, 15 | 10 | 5 | 0 |
| | 92 | 13⅝ | 3 | 10 | 5 | 0 |
| | 48 | 22⅛ | 3 | 18 | 6 | 0 |
| | 45 | 22⅛ | 3 | 18 | 11 | 0 |
| Cape Copper ...... | 50 | 24⅛ | 8, 11 | 19 | 12 | 0 |
| | 47 | 24⅛ | 8, 11, 13 | 19 | 12 | 0 |
| | 44 | 21½ | 11 | 17 | 4 | 0 |
| | 43 | 24⅜ | 6 | 20 | 0 | 0 |
| | 18 | 26⅛ | 6 | 21 | 8 | 0 |
| | 27 | 22½ | 2 | 17 | 18 | 0 |
| Knockmahon ... | 65 | 11⅛ | 5, 7 | 9 | 6 | 6 |
| | 60 | 11⅛ | 7 | 9 | 6 | 6 |
| Yudanamutana... | 40 | 36⅞ | 6 | 28 | 15 | 0 |
| | 50 | 37 | 6 | 28 | 15 | 0 |
| | 35 | 30⅛ | 6 | 23 | 14 | 0 |
| Gt. Northern (S.A.) | 46 | 24 | 15 | 18 | 18 | 0 |
| | 45 | 24½ | 2, 15 | 19 | 3 | 0 |
| | 1 | 34½ | 2 | 27 | 6 | 6 |
| Laxey ............ | 117 | 6⅛ | 7 | 5 | 0 | 0 |
| Kanmantoo ...... | 13 | 51⅛ | 6 | 41 | 10 | 0 |
| | 10 | 51½ | 6 | 41 | 10 | 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. £ | s. | d. |
|---|---|---|---|---|
| Berehaven ............... | 718 | £5,889 | 16 | 6 |
| Chili ........................ | 663 | 8,834 | 13 | 6 |
| Cobre........................ | 518 | 6,041 | 9 | 0 |
| Cape Copper ............ | 229 | 4,386 | 10 | 0 |
| Knockmahon ............ | 125 | 1,165 | 12 | 6 |
| Yudanamutuna ......... | 125 | £3,417 | 0 | 0 |
| Great Northern (S.A.) | 92 | 1,758 | 9 | 0 |
| Laxey ..................... | 117 | 817 | 18 | 6 |
| Kanmantoo ............... | 23 | 954 | 10 | 0 |

## EACH COMPANY'S PURCHASE.

| | | Tons. | Amount. £ | s. | d. |
|---|---|---|---|---|---|
| 1 | Copper Miners Co. ......... | 54 | £642 | 12 | 0 |
| 2 | Freeman and Co............... | 113½ | 1,461 | 4 | 6 |
| 3 | P. Grenfell and Sons ......... | 535 | 6,193 | 10 | 0 |
| 4 | Crown Copper Co. ............ | — | — | | |
| 5 | Sims, Willyams, Nevill & Co | 147 | 1,486 | 0 | 9 |
| 6 | Vivian and Sons ............ | 392 | 5,162 | 6 | 0 |
| 7 | Williams, Foster & Co. ...... | 463½ | 3,590 | 16 | 0 |
| 8 | British and For. Copper Co. | 90⅝ | 1,492 | 1 | 4 |
| 9 | Mason and Elkington ...... | 104 | 1,361 | 9 | 6 |
| 10 | Bankart and Sons ...... | 94 | £1,232 | 5 | 0 |
| 11 | Charles Lambert ......... | 294⅝ | 3,688 | 0 | 10 |
| 12 | Ravenhead Copper Co. | — | — | | |
| 13 | Sweetland, Tuttle & Co. | 125⅝ | 1,225 | 11 | 4 |
| 14 | Jennings and Co.......... | — | — | | |
| 15 | Neath Copper Co.......... | 196 | 2,500 | 1 | 9 |
| 16 | Penclawdd Copper Co | — | — | | |
| | Total ............... | 2,610 | £33,035 | 19 | 0 |

# Sundry Copper Ore Sales.

| Date. | Mines | Tons. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|
| May 27. | Lot 1 Knockmahon (ex Johanna) | 65 ... | 7 | 4 | 0 | Bibby Sons & Co. ...... / St. Helen's Co............. | | | |
| | 2 ,, ,, | 65 ... | 6 | 14 | 6 ... | Bibby Sons & Co. ...... | | | |
| | 3 (ex Matilda) ............... | 64 ... | 9 | 0 | 6 ... | ditto ...... | | | |
| | 4 ,, ............... | 65 ... | 8 | 14 | 0 ... | J. Keys & Sons ......... | 3,363 | 17 | 0 |
| | 5 ,, ............... | 65 ... | 8 | 16 | 6 ... | Bibby Sons & Co. ...... | | | |
| | 6 (ex Sea Bird) .............. | 56 ... | 4 | 9 | 0 ... | ditto ...... | | | |
| | 7 ,, ............... | 56 ... | 4 | 7 | 6 ... | ditto ...... | | | |
| | 8 ,, ............... | 56 ... | 4 | 8 | 6 ... | ditto ...... | | | |
| June 3. | Knockmahon (ex Lady Stuart) | 48 ... | 8 | 12 | 0 ... | St. Helen's Co............ | | | |
| | ,, ,, | 48 ... | 8 | 13 | 6 | ditto ...... / Newton, Keates & Co. | 1,452 | 0 | 0 |
| | ,, (ex Mary Joseph) | 72 ... | 4 | 6 | 0 ... | ditto ... | | | |
| | ,, ,, | 72 ... | 4 | 7 | 0 ... | ditto ... | | | |
| | West Canada (ex Damascus)... | 50 .. | 16 | 0 | 0 ... | C. Lambert .............. | | | |
| | ,, ,, ... | 50 ... | 15 | 18 | 0 | ditto ......... / Sims, Willyams & Co. | 3,279 | 15 | 0 |
| | ,, (ex Louisiana) ... | 50 ... | 16 | 6 | 0 ... | ditto | | | |
| | ,, ,, ... | 63 ... | 16 | 3 | 0 ... | ditto | | | |
| ,, 16. | Lot 1 Parys Mines .............. | 165 ... | 5 | 17 | 6 ... | C. Lambert ............... | 1,928 | 15 | 0 |
| | 2 ,, .............. | 165 ... | 5 | 17 | 6 ... | ditto ............... | | | |

# Copper Ores.

Sampled May 27, and sold at Swansea June 16.

| Mines. | Tons. | Produce. | Purchasers. | Price. | | |
|---|---|---|---|---|---|---|
| Berehaven | 130 | 10⅝ | 5 | £8 | 2 | 0 |
| | 67 | 10⅝ | 7 | 8 | 1 | 6 |
| | 80 | 10¼ | 5 | 8 | 2 | 0 |
| | 74 | 10⅝ | 5 | 8 | 3 | 0 |
| | 122 | 10⅝ | 5, 6 | 8 | 4 | 0 |
| | 82 | 10½ | 6 | 8 | 4 | 0 |
| Cobre | 92 | 12⅞ | 6 | 9 | 14 | 0 |
| | 87 | 12⅞ | 6 | 9 | 13 | 0 |
| | 82 | 12¼ | 6 | 9 | 13 | 0 |
| | 101 | 12⅝ | 7, 15 | 9 | 14 | 0 |
| | 100 | 12⅞ | 7 | 9 | 18 | 6 |
| | 27 | 25⅝ | 2 | 19 | 18 | 0 |
| West. Australian | 66 | 20⅝ | 3, 6 | 15 | 19 | 0 |
| | 65 | 20½ | 3 | 15 | 19 | 0 |
| | 53 | 20⅝ | 3 | 16 | 12 | 0 |
| | 74 | 20 | 6 | 15 | 19 | 6 |
| Knockmahon | 52 | 9⅝ | 9 | 7 | 18 | 0 |
| | 50 | 9⅝ | 1, 2 | 7 | 16 | 6 |
| | 75 | 10⅜ | 7, 15 | 8 | 11 | 6 |

| Mines. | Tons. | Produce | Purchasers | Price | | |
|---|---|---|---|---|---|---|
| Cape Copper | 59 | 38 | 10 | £31 | 5 | 6 |
| | 43 | 21½ | 14 | 17 | 16 | 6 |
| | 50 | 30½ | 3 | 25 | 5 | 6 |
| Ballycummisk | 8 | 17⅜ | 2 | 14 | 6 | 0 |
| | 60 | 11⅞ | 7 | 9 | 11 | 0 |
| | 57 | 4¼ | 2 | 2 | 19 | 0 |
| Copper Slag | 89 | 3 | 5 | 1 | 6 | 0 |
| Cappagh | 17 | 20⅜ | 5 | 16 | 13 | 0 |
| | 34 | 10⅝ | 13 | 8 | 11 | 0 |
| | 25 | 6½ | 2, 3 | 4 | 12 | 0 |
| | 1 | 45 | 14 | 39 | 0 | 0 |
| Brada United | 32 | 4⅞ | 7 | 3 | 6 | 0 |
| African | 14 | 15⅝ | 14 | 12 | 6 | 6 |
| | 3 | 23⅝ | 6 | 19 | 2 | 0 |
| Gualla | 3 | 23⅞ | 6 | 18 | 5 | 0 |
| | 2 | 39⅝ | 6 | 31 | 13 | 0 |
| Cronbane | 2 | 30 | 10 | 22 | 10 | 6 |
| Tigrony | 2 | 30 | 5 | 22 | 12 | 0 |

TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Berehaven | 555 | £4,517 | 18 | 6 |
| Cobre | 489 | 5,032 | 15 | 0 |
| Western Australian | 258 | 4,149 | 11 | 0 |
| Knockmahon | 177 | 1,445 | 3 | 6 |
| Cape Copper | 152 | 3,875 | 9 | 0 |
| Ballycummisk | 125 | 855 | 11 | 0 |
| Copyer Slag | 89 | 115 | 14 | 0 |

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Cappagh | 77 | £727 | 15 | 0 |
| Brada United | 32 | 105 | 12 | 0 |
| African | 17 | 229 | 17 | 0 |
| Gualla | 5 | 118 | 1 | 0 |
| Cronebane | 2 | 45 | 1 | 0 |
| Tigrony | 2 | 45 | 4 | 0 |

EACH COMPANY'S PURCHASE.

| | | Tons. | Amount. | | |
|---|---|---|---|---|---|
| 1 | Copper Miners' Co. | 25 | £195 | 12 | 6 |
| 2 | Freeman and Co. | 129½ | 1,072 | 19 | 6 |
| 3 | Grenfell and Sons | 213½ | 3,764 | 3 | 0 |
| 4 | Crown Copper Co. | — | —— | | |
| 5 | Sims, Willyams, Nevill & Co. | 453 | 3,248 | 5 | 0 |
| 6 | Vivian and Sons | 475½ | 5,158 | 1 | 6 |
| 7 | Williams, Foster & Co. | 390½ | 3,443 | 6 | 3 |
| 8 | British and For. Copper Co. | — | —— | | |
| 9 | Mason and Elkington | 52 | 410 | 16 | 0 |

| | | Tons. | Amount. | | |
|---|---|---|---|---|---|
| 10 | Bankart and Sons | 61 | £1,890 | 5 | 6 |
| 11 | Charles Lambert | — | —— | | |
| 12 | Ravenhead Copper Co. | — | —— | | |
| 13 | Sweetland, Tuttle & Co. | 34 | 290 | 14 | 0 |
| 14 | Jennings & Co. | 58 | 978 | 0 | 6 |
| 15 | Neath Copper Co. | 88 | 811 | 8 | 3 |
| 16 | Penclawdd Copper Co. | — | —— | | |
| | Total | 1,930 | £21,263 | 12 | 0 |

# Black Tin Sales.

| Date. | | Mines. | Tons | c. | q. | lbs. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 11. | Atlas | 0 | 6 | 3 | 9 | 68 | 5 | 0 | Carvedras | 85 | 9 | 8 |
| | | ,, | 1 | 0 | 2 | 6 | 60 | 10 | 0 | ditto | | | |
| ,, | 16. | Wendron Consols | 18 | 15 | 3 | 26 | — | | | Chyandour | 1234 | 6 | 6 |
| ,, | 23. | New Wh. Prospidnick | 4 | 9 | 1 | 6 | 65 | 0 | 0 | Treriffe Co. | 290 | 18 | 4 |
| ,, | 30. | Garlidna United | 8 | 12 | 2 | 12 | 70 | 5 | 0 | Bissoe Co. | 710 | 8 | 2 |
| | | ,, | 2 | 1 | 2 | 17 | 50 | 0 | 0 | — | | | |
| | | South Carn Brea | 7 | 2 | 3 | 8 | 64 | 0 | 0 | — | 460 | 4 | 7 |
| June | 1. | Cuddra | 3 | 5 | 2 | 17 | 67 | 0 | 0 | — | 227 | 1 | 6 |
| | | ,, | 0 | 2 | 3 | 12 | 50 | 0 | 0 | — | | | |
| ,, | 2. | Great Wheal Busy | 20 | 10 | 2 | 19 | — | | | — | 1264 | 7 | 9 |
| | | West Beam | 8 | 6 | 2 | 17 | 72 | 15 | 0 | Harvey & Co. | 606 | 3 | 11 |
| | | Bagtor | 3 | 0 | 3 | 3 | 64 | 2 | 6 | ditto | 194 | 17 | 3 |
| ,, | 4. | Leeds & St. Aubyn | 4 | 17 | 0 | 23 | 70 | 10 | 0 | Chyandour | 342 | 13 | 0 |
| ,, | 8. | Bottle Hill | 4 | 0 | 0 | 0 | 66 | 15 | 0 | Charlestown Co. | 267 | 0 | 0 |
| | | Great Wh. Vor United | 30 | 12 | 3 | 8 | — | | | — | 2260 | 2 | 6 |
| | | Gurlyn | 4 | 8 | 0 | 10 | 65 | 0 | 0 | Chyandour | 285 | 5 | 6 |
| | | St. Day United | 51 | 11 | 3 | 1 | — | | | — | 3114 | 11 | 11 |
| ,, | 18. | Wendron Consols | 19 | | 0 | 10 | — | | | Chyandour, Bissoe, Treriffe | 1338 | 3 | 7 |

# Lead Ore Sales.

| Dates. | | Mines. | Tons. | Price per Ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|
| May | 16. | Carmarthen United | 32 | 13 | 13 | 0 | Sims, Willyams & Co. | 537 | 6 | 0 |
| | | ,, | 10 | 10 | 1 | 0 | ditto | | | |
| ,, | 28. | Maesysafn | 60 | 12 | 9 | 0 | Walker, Parker & Co. | 747 | 0 | 0 |
| | | Mount Pleasant | 10 | 12 | 1 | 0 | Newton, Keates & Co. | 120 | 10 | 0 |
| | | Bryngwyn | 10 | 12 | 17 | 6 | Walker, Parker & Co. | 245 | 3 | 0 |
| | | ,, | 8 | 14 | 11 | 0 | A. Eyton | | | |
| | | Pant-y-Mwyn | 9 | 12 | 11 | 0 | ditto | 112 | 19 | 0 |
| | | Pool Park | 43 | 13 | 7 | 0 | Walker, Parker & Co. | 574 | 1 | 0 |
| | | Dyliffe | 64 | 12 | 16 | 6 | Newton, Keates & Co. | 820 | 16 | 0 |
| | | Llanerchyraur | 20 | 13 | 6 | 0 | A. Eyton | 266 | 0 | 0 |
| ,, | 30. | Ludcott & Wrey Consols | 60 | 17 | 17 | 0 | Sims, Willyams & Co. | 1071 | 0 | 0 |
| | | Cwmbrane | 8¼ | 11 | 14 | 0 | ditto | 96 | 10 | 6 |
| June | 1. | East Logylas | 40 | 12 | 11 | 0 | ditto | 502 | 0 | 0 |
| | | Glogfach | 60 | 15 | 16 | 0 | ditto | 948 | 0 | 0 |
| | | Cwmystwith | 100 | 12 | 13 | 0 | ditto | 1265 | 0 | 0 |
| | | Goginan | 6 | 16 | 11 | 0 | ditto | 688 | 0 | 0 |
| | | ,, | 6 | 16 | 11 | 0 | A. Eyton | | | |
| | | ,, | 28 | 17 | 11 | 0 | ditto | | | |
| ,, | 3. | Dyfngwm | 24 | 12 | 12 | 6 | ditto | 303 | 0 | 0 |
| ,, | 4. | Isle of Man Mining Co. | 100 | 21 | 15 | 0 | Newton, Keates & Co. | 2175 | 0 | 0 |
| | | Minera | 100 | 13 | 8 | 6 | Walker, Parker & Co. | 7680 | 14 | 0 |
| | | ,, | 100 | 13 | 8 | 6 | ditto | | | |
| | | ,, | 100 | 13 | 8 | 6 | ditto | | | |
| | | ,, | 50 | 13 | 10 | 6 | Mining Co. of Ireland | | | |
| | | ,, | 107 | 13 | 6 | 6 | Walker, Parker & Co. | | | |
| | | ,, | 107 | 13 | 6 | 6 | ditto | | | |
| | | ,, | 11 | 11 | 8 | 0 | Sims, Willyams & Co. | | | |
| ,, | 11. | Talargoch (Maesyrerwddu) | 64 | 13 | 19 | 0 | A. Eyton | 2858 | 15 | 0 |
| | | ,, (Coetia Llys) | 137 | 14 | 7 | 0 | Walker, Parker & Co. | | | |
| | | Deep Level | 5 | 12 | 11 | 0 | A. Eyton | 62 | 15 | 0 |
| | | Rhosesmor | 33 | 13 | 6 | 0 | Newton, Keates & Co. | 444 | 18 | 0 |
| | | Parry's | 30 | 13 | 5 | 6 | Walker, Parker & Co. | 398 | 5 | 0 |
| | | Bryn Gwiog | 35 | 13 | 9 | 0 | A. Eyton | 470 | 15 | 0 |
| | | Long Rake | 12 | 13 | 0 | 6 | ditto | 156 | 6 | 0 |
| | | Orsedd | 5 | 12 | 17 | 6 | ditto | 64 | 7 | 6 |
| | | North Henblas | 10 | 12 | 3 | 0 | Walker, Parker & Co. | 121 | 10 | 0 |
| | | Speedwell | 16 | 12 | 7 | 0 | Newton, Keates & Co. | 197 | 12 | 0 |
| | | Llangynog United | 30 | 12 | 11 | 0 | ditto | 376 | 10 | 0 |
| | | Cefn Cilcen | 10 | 12 | 13 | 0 | ditto | 126 | 10 | 0 |
| | | Llanerchyraur | 16 | 13 | 9 | 0 | ditto | 215 | 4 | 0 |
| | | Merllyn | 3 | 12 | 7 | 0 | ditto | 37 | 1 | 0 |
| | | Wheal Mary Ann | 52 | 25 | 7 | 6 | Stock & Co. | 1649 | 10 | 0 |
| | | ,, | 22 | 15 | 0 | 0 | ditto | | | |
| ,, | 12. | Great Laxey | 100 | 19 | 2 | 0 | Sims, Willyams & Co. | 1910 | 0 | 0 |
| | | Cargoll | 85 | 17 | 2 | 6 | J. & J. Williams | 1455 | 12 | 6 |
| ,, | 13. | Harwood | 30 | 12 | 8 | 9 | London Lead Co. | 372 | 3 | 6 |
| ,, | 15. | Frongoch | 75 | 12 | 11 | 0 | Sims, Willyams & Co. | 1900 | 0 | 0 |
| | | ,, | 75 | 12 | 15 | 0 | ditto | | | |
| | | East Darren | 80 | 15 | 9 | 6 | J. and J. Williams | 1238 | 0 | 0 |
| | | Cwm Erfin | 25 | 15 | 13 | 0 | Walker, Parker & Co. | 946 | 17 | 6 |
| | | ,, | 35 | 15 | 17 | 6 | ditto | | | |
| ,, | 17. | Minera Union | 26 | 12 | 13 | 0 | Sims, Willyams & Co. | 328 | 18 | 0 |
| ,, | 18. | Dyliffe | 66 | 13 | 1 | 0 | Newton, Keates & Co. | 1572 | 3 | 6 |
| | | ,, | 55 | 12 | 18 | 6 | Walker, Parker & Co. | | | |

THE

# MINING AND SMELTING MAGAZINE.

AUGUST, 1863.

## On the Manufacture of Pig-Iron in England.

BY MM. GRUNER AND LAN.

(Abstracted from the *Annales des Mines*, 5th series, vol. xx, p. 109.)

(*Continued from page* 15.)

### IV.—ACCESSORY APPLIANCES OF BLAST-FURNACES.

1. *Casting Houses.*—The accessory constructions of English blast-furnaces are generally extremely simple—indeed almost too primitive in many respects. In Wales and Staffordshire a few sheds are here and there met with; but in the North and in Scotland almost all the blast-furnaces are completely open to the weather. The men work winter and summer in the open air; and although the climate of the United Kingdom is rarely extreme in its temperature, it still requires the robust constitution of the English labouring classes to support conditions involving such a total absence of comfort.

2. *Lifting Apparatus.*—The general arrangement of any works in this respect depends on the configuration of the surface. In Wales the greater number of the furnaces are built at the foot of a declivity, in which case the calcining furnaces and coke ovens are on a level with the furnace-top, so that the materials have merely to be wheeled in on a level (Dowlais, Cyfarthfa, Abersychan, Pontypool, Sirhowy, Beaufort, Blaenavon, &c.). In the Cleveland district the works are on a level plain; and in Staffordshire and in the neighbourhood of Glasgow the greater portion of the furnaces are similarly erected on a comparatively level country. In this latter case the ordinary lifting apparatus of the old works was an inclined plane, worked by a fixed engine—an arrangement which Truran very properly condemns as inconvenient and costly.

In the more modern works we generally meet with either the water-balance lift or the pneumatic lift. The water-balance lift is sufficiently known, and is a convenient apparatus except during the

winter frosts. The pneumatic lift, which is used almost exclusively in the Cleveland works, is still more simple, and less subject to derangement; indeed, of all lifting apparatus, it is evidently the most convenient to erect. It is composed essentially of a wrought-iron gasometer cylinder, of the height of the blast-furnace, open at the end and closed at the top, which is worked inverted in a well of equal depth. A bent pipe connects the interior of this cylinder with the blowing-engine—regulated by a stop-valve; the cylinder itself being completely balanced by means of four chains with adequate weights attached. On the top of the cylinder a suitable platform is fixed, from 6′ to 7′ square, on which the loaded barrows are wheeled by the workman; who, as soon as they are placed, opens the stop-valve so that the blast presses against the top of the tube and forces up the cylinder. The descent of the empty barrows is regulated by an escape-valve at the top of the cylinder. A pneumatic lift of 3′ 8″ to 4′ 4″ diameter may thus serve to supply three blast-furnaces; the friction being trifling, the power of the blast is almost completely utilised, and the apparatus rarely gets out of order.

Truran shows that allowing 8*d.* as the cost of compressing 100,000 cubic feet of blast (which is that at the Welsh works), the expense of raising by pneumatic lifts would not exceed ⅝*d.* per ton of iron made, including interest of erecting and cost of maintaining apparatus.

3. *Mode of Charging. Collection of Waste Gases.*—The throats of blast-furnaces are usually open, or, at most, surmounted by a chimney or "tunnel head," from 10′ to 12′ high, at the base of which are from three to five openings, through which the furnace is charged. In this case it is usually charged with barrows; or at least tip-waggons are only used for furnaces with narrow throats, as at Lowmoor.

When the gases are utilised a very simple plan of collecting is frequently used, which serves at the same time as a distributing apparatus (Ebbwvale, Victoria, Dowlais, &c.). It consists of a conical casting, which, with the apex upwards, fits against the lower edge of a cup or funnel-shaped casting, resting on the top of the furnace. This cone is suspended from a lever which is counter-balanced at the other end, and the charge is thrown from the barrow into the space between the cone and the funnel. When this is done the cone is lowered by a suitable gearing, and the ore and fuel fall into the furnace, which is immediately again closed by the counter-poise at the opposite end of the lever causing the stopper-cone to return to its original place. (See *Mining and Smelting Magazine*, vol. i, Plate III, fig. 11.) The result of this mode of charging is that the materials are thrown towards the circumference of the furnace, while there is formed in the centre a kind of conical hollow, into which the larger pieces have a tendency to roll; so that the central column is rendered more permeable, which combats the tendency of the gases to follow the walls of the body. By this arrangement the gaseous products are drawn through simple openings in the walls of the furnace, immediately above the charge. It is evident, however, that in the case of very large furnaces, this arrangement would be insufficient entirely to avoid the unequal

distribution of the gases; in this case it would be necessary, as we have said, to have recourse to M. Coingt's system of collecting from the centre of the furnaces. In some of the Cleveland works (Tees-side), and of Wales (Aberdare, Ystalyfera, &c.), the system of the moveable cone has been replaced by the old plan of a fixed iron cylinder sunk into the furnace—a plan used on the Continent for small throats. (See *Mining and Smelting Magazine*, vol. i, Plate III, fig. 7.)

4. *Removal of the Slags.*—In addition to the apparatus described for lifting the charges, we may mention the means adopted by the English smelters for the removal of the slags. In the large English works it is very rare to see the slags allowed to run out about the furnace. They are almost always made to flow into large wrought-iron tip-waggons ("cinder-tubs"), removed by rail, by horse or steam power (the latter being usually a fixed engine working an endless rope), to the waste heaps which are often from 75' to 100' high. This is a considerable source of economy and is well worthy of imitation in the French works. The greater number of the Welsh blast-furnaces produce per day from 40 to 50 tons of slag, and some of the larger ones from 60 to 80.

5. *Blowing Engines.*—In order to arrive at a large make, it is not merely sufficient to increase the capacity of the furnaces, it is also essential proportionately to increase the volume of blast. For this reason it has been necessary during the last thirty years to more than double the dimensions of the blast-engines in the English works. The increased height of the furnaces and the heating of the blast have likewise increased the resistance, and thus also entailed an increase in the motive power.

Formerly, none but the Watt engines—low pressure condensing—were used in the English works; and the diameter of the blowing-cylinder, at the one extremity of the beam, was always exactly double that of the steam-cylinder at the other extremity. At present, high-pressure engines, with or without expansion, are most usually employed, in which case the steam-cylinder is relatively smaller.

Horizontal blowing-engines are rare in England, where it has been recognised, as on the Continent, that the advantage resulting from the greater simplicity and cheapness of their erection is more than balanced by the more rapid and unequal wear and tear of the pistons and blowing-cylinders, as well as by the shortness of the stroke. Indeed, such engines are only applicable where the volume of blast is not very considerable.

Direct acting vertical engines, without beams, are equally rare, but on the Continent this system seems to be spreading. A kind of mixed arrangement is met with in several of the Welsh works, in the form of a Woolf's double cylinder beam engine. At the end of one arm of the beam hangs the sweep-rod of the fly-wheel; and on the same arm, but nearer the axis, is the high-pressure cylinder. At the end of the other arm of the beam is the second and larger steam-cylinder, and vertically beneath it, working directly, the blowing-cylinder. An engine of this kind, of 150 H.P., was erected at Cyfarthfa in 1851; and a similar Woolf's engine with a con-

denser, of 300 H.P., is at work at Dowlais; the sizes of the cylinders being 32″ and 50″.

Engines with slide valves, which at one time enjoyed a passing favour in France, seem never to have been adopted in England—at least we have nowhere met with them. Indeed the superiority of engines with clack-valves, in respect of effective work, has recently been proved at Creusot; for while the ratio of the blast produced to that of the steam consumed was found, in the case of a vertical beam-engine with clack-valves, to be—

0·6825, 0·687, and 0·690

with pistons working at the respective velocities of—

150 feet, 200 feet, and 240 feet;

in the case of three horizontal engines, with slide valves, it varied between—

| | | | | | | |
|---|---|---|---|---|---|---|
| 0·620 | and | 0·663 | at a velocity | of | 430 | feet |
| 0·604 | ,, | 0·616 | ,, | | 360 | ,, |
| 0·417 | ,, | 0·460 | ,, | | 300 | ,, |

The result being that it was decided to do away with the slide valve engines at Creusot.

The figures we have given show that the effective power of vertical clack-valve engines slightly increases with the velocity of the pistons; so that it would seem most advantageous, in this respect, to work at a high velocity—which is, in fact, the tendency of the English makers. Indeed we can quite understand why this should be so, since, independently of the greater effective power, there is the additional advantage of obtaining with an apparatus of given dimensions a greater volume of blast.

The ordinary velocity of the old blowing-engines of the Watt type was 200′ per minute: at present, in England, it is endeavoured to reach an average of 400′—and it has even been attempted, in some works, to attain as much as 600′, but the vibration in this case becomes so great as to endanger the stability of the apparatus. Even for a velocity of 400′ a simple form of engine is required, without complicated gearing: the Watt engine would scarcely sustain it. It is necessary besides, so as not to interfere with the movement of the blast, to have machines with a long stroke, and large air-ways. In the largest blowing-engine in England, the monster engine at Dowlais, the ratio of the area opened by the wind-valves for the admission of air to that of the blowing-cylinder is upwards of half; and we have seen this engine working with a velocity of 400′ per minute (17 double strokes) without any sensible vibration or strain on the valves: Mr. Truran states that it may be worked as high as 19 strokes, or a velocity of 450′ per minute. This enormous engine is high-pressure, non-condensing: the diameter of the steam-cylinder is 55″, the stroke of the piston 13′, and the pressure of the steam 40 lb. per square inch. The beam is 42′ long (unequal), and there are eight boilers heated by the gases from two blast-furnaces. The diameter of the blowing-piston is 144″, with a 12′ stroke. On the day of our visit this colossal engine supplied blast for six blast-furnaces and four refineries.

The size of this engine is no doubt exceptional, and it may be questioned if it is really wise to make the working of six or eight blast-furnaces dependant on one single blowing-engine—for in any case spare engines are necessary. But at present in all the modern English works, particularly those of Cleveland, vertical engines with a long stroke and a velocity of about 400′ per minute are being everywhere adopted; replacing to a great extent the old blowing-engines of from 60″ to 80″ diameter and 5′ to 6′ 6″ stroke. Instead of from 25 to 30 H.P. per blast-furnace (*Voyages Métallurgiques*, vol. i, page 317–350), at present from 60 to 75 H.P. and even upwards is calculated. But it must be remembered that these modifications would be far from producing the results at present obtained if, at the same time, the delivery valves were not as numerous and as large as possible.

It is by the combination of these improvements—including the boilers, the motive engine, and the blowing apparatus—that they have succeeded in England, as Mr. Truran has pointed out, in reducing the consumption of coal in the ratio of two and even three to one per cubic foot of blast supplied. Indeed the old Welsh blowing-engines, about 1830, only produced per lb. of coal 400 cubic feet of blast; while the modern Dowlais engines produce as much as 800 or 900—and even in the monster engine above mentioned 1,328 cubic feet, according to Mr. Truran. We may add, however, that the heating power of the Welsh coal is a third if not a half higher than that of Glasgow coals—so that a portion of this saving in fuel is attributable to the better quality of the coal. In the Cleveland district, and in a certain number of the Welsh works, the boilers are heated by the furnace gases. They are frequently of the form of the Cornish engines—cylindrical, with an interior tube.

6. *Hot-air Apparatus.*—The use of heated air for blast-furnaces has been generally adopted in England, and the use of cold air is only continued in those works whose object is to produce cast and wrought iron of an exceptional tenacity (Lowmoor, Bowling, Pontypool, Blaenavon, and a few works in Staffordshire). The blast is generally heated to the melting point of lead, 320° to 330° C. (608° to 626° Fahr.), and in several works in Scotland as high as 400° C. (752° Fahr.).

The apparatus still employed, with the exception of a few modifications, are similar to those described by the authors of the *Voyages Métallurgiques.* In the Cleveland district and in Scotland the syphon apparatus, known in France as the Calder system, is generally used, except that the arched heating-pipes have a more or less flattened or elliptical, instead of the old circular, sectional form—as is also the case in some of the Continental works (Belgium). This is evidently an improvement in respect of heating the air, but on the other hand the resistance to the movement of the blast is slightly increased.

In some works a separate stove is erected for each twyer-embrasure, but in others a single very large stove is used to heat the blast for all the twyers. It is asserted that it is easier to heat in a uniform manner in a large apparatus than in a small one. But however this may be, the preference seems to be given to numerous

single stoves; for in the new works at Cleveland we constantly see two stoves side by side between two contiguous blast-furnaces.

In some works the ordinary Calder system has been slightly modified so as to remedy the inconvenience of the rapid wearing out of the pipes at the crown of the arch. We may instance the system adopted at the Clarence works, near Middlesboro', where the joining-bend at the crown of the syphon has been done away with, and each of the heating-pipes—slightly arched and completely independent of the opposite demi-syphon heating-pipe—is closed at the top, but is provided with an interior partition which obliges the air to pass successively up one side and down the other of the pipe. Again at the Gartsherrie works, in Scotland, the curves of the demi-syphons have been complicated, so as to increase the heating surface. We shall describe further on this singular apparatus, in which, in endeavouring to obtain very uncertain advantages, the great inconvenience has been incurred of adopting forms difficult to cast and subject to fracture from the unequal expansion and contraction of the metal. In general the simpler an apparatus is the more meritorious it is in the eyes of the practical man; now in this respect the ordinary Calder system, with heating tubes of an oblong section, seems to us preferable to any other, when the object is to heat the blast by the direct combustion of the coal.

On the other hand, when the furnace gases are used, the *Wasseralfingen* apparatus is preferable. In Continental works this is often met with, but it seems to be unknown in England. In its place, however, an apparatus has been adopted in the Welsh works, composed, like the Wasseralfingen, of a single line of spiral pipe, arranged horizontally, but which has not, like it, the advantage of having the joints protected from the fire (Ebbwvale, Aberdare, &c.). The pipes are from 7¾″ to 8″ in diameter, or are sometimes elliptical (9″ by 6″) as at Aberdare. Each pipe forms a half of the spiral helix, the length of which, in each of the apparatus, is about 13′, the exterior diameter of the curve being about 6′ 6″. The pipes are connected by socket-joints, and the whole is placed in a stove of cylindrical form. This system is evidently inferior to that of the Wasseralfingen, for the joints require very frequent repairs. The gases are burnt in the usual manner, and the fire-place is kept supplied with incendescent coal to avoid the danger of explosions.

According to Truran, the general rule in England with respect to hot-air stoves is to provide approximately one square foot of heating surface for each cubic foot of blast to be heated. At the new apparatus at the Gartsherrie works, however, the heating surface does not exceed ·8 square foot per cubic foot of blast. It is evident of course that, as in the case of steam boilers, a larger heating surface is required in those stoves where furnace gases are employed than in those where coal is burnt.

7. *Twyers and Nozzles; Pressure, Temperature, and Volume of Blast.*—In mere construction, the twyers and nose-pipes used in England require no special notice, but in some districts their number has been singularly multiplied. In Wales and Staffordshire from five to seven are met with, and in Scotland from eight to ten. There can be no doubt that when the diameter of the hearth exceeds

from 6′ to 6′ 6″, it is difficult to attain a complete uniformity of temperature with two or three twyers; for the recent experiments of M. Tunner have proved how much the heat may vary, under such circumstances, at different points of the hearths of blast-furnaces. Hence, in theory, the use of a large number of twyers seems advisable; in practice, however, the advantages are very doubtful. The furnaces do not work better, nor is the make or yield changed, while the repairs of the hearth and of the twyers become more costly and difficult. There seems, consequently, to be again a general return to a more limited number of twyers and to more moderate sized hearths—at least when the ores are not very fusible. In the Cleveland district, in particular, where the ores are refractory, the preference is given to working the furnaces with three twyers. In any case we must condemn the system which does not place all the twyers at the same level. Thus, in several of the Welsh works, there are two twyers in each house, 2′ 6″ above the level of the sole, and a seventh in the breast in the middle of the tymp, at least 3′ 4″ from the sole (Dowlais); or five twyers at regular intervals, and a sixth higher up in front (Ebbwvale and Abersychan). It has been found that under this arrangement the tymp is difficult to maintain, and that the temperature is too intense about the breast. Again, at Yniscedwin and Ystalyfera, there are three twyers per house, two of which are 2′ 6″ high, and the middle one from 6″ to 8″ higher. At Ystalyfera there is a sixth twyer in the tymp. It is true that the centre twyer, at least at Yniscedwin, is only used in case of obstruction.

The pressure of the blast, in the greater number of works, is generally comprised between 2½ and 3 lbs. per square inch. In the anthracite district of Swansea, however, it is oftener from 3 to 4 lbs., and a similar high pressure is necessary in the 50′ or 60′ blast-furnaces of Scotland, to overcome the increased resistance arising from this great height.

The temperature of the blast, when working with hot air, is generally that of the fusion of lead, 320° to 330° C. (572° to 626° Fahr.). In Scotland only is the high temperature of 400° C. (752° Fahr.) attained in some works. As has been already stated, cold air is still used when it is desired to obtain highly tenacious products.

The volume of the blast, or the diameter of the nose-pipes, regulates the production; it depends consequently on the capacity of the furnace. When the number of the nose-pipes is considerable, and the make is still small, as at Ystalyfera, their diameter is only 2″; but more usually the diameter of the nozzles ranges from 3″ to 3½″: it reaches as much as 4″ when the furnace is worked with three twyers.

Knowing the pressure and temperature of the air, as well as the number and diameter of the nose-pipes, we can calculate the volume of the blast. But the figure thus got is always too high, not only because a portion of the blast escapes, but principally because the formula assumes that the air passes out freely—and no account is taken of the considerable resistance which the column of materials in the blast-furnace opposes to the entry of the air. Indeed, we can

easily assure ourselves that the volume thus calculated is too high by comparing it with the results obtained, admitting that the oxygen, necessary for the transformation of the carbon into the oxide of carbon, is derived exclusively from the injected air. And even the volume thus calculated is itself already a maximum, since a portion of the oxygen is constantly obtained from the oxide of iron—particularly in the treatment of difficultly reducible ores like forge-cinders. It is, therefore, more exact to calculate the volume of the blast from the weight of fuel consumed, starting on the basis that 1 lb. of coal requires for its transformation into oxide of carbon, 5·8 lbs., or 157 cubic feet, of ordinary dry air, measured at a temperature of zero (C.) and a pressure of 30″.

We thus find, as we shall see by the table further on, that per ton of black pig-metal there is consumed in Scotland from 175,000 to 190,000 cubic feet of blast; and as the make of the large Scotch furnaces is 24 tons per twenty-four hours, or 1 ton per hour, the volume of air consumed per minute amounts at the maximum to $\frac{175,000 \text{ or } 190,000}{60}$ cubic feet = 3,000 cubic feet, or about 13½ cubic feet per cubic yard of capacity of furnace (or ½ cubic foot per cubic foot of capacity).

In Wales, the ordinary blast-furnaces making forge-pig receive in general from 175,000 to 200,000 cubic feet per ton of pig-metal, or from 2,900 to 3,300 cubic feet per minute; but as their capacity is less the greater number of them in reality consume as much as 17½, or even 20 cubic feet of blast per cubic yard of capacity (or ·65 and ·75 cubic foot per cubic foot of capacity). It is the same with the large Dowlais furnace, which receives 6,000 cubic feet of blast for a capacity of 300 cubic yards.

In Staffordshire and the Cleveland district, where the ores are not so rich as in Scotland, the consumption of hot air per ton of grey pig-metal is from 210,000 to 250,000 cubic feet, or from 15 to 17½ cubic feet per yard of capacity (·55 to ·65 cubic foot per cubic foot of capacity). In the case of the furnaces working with cold air, and making a tenacious grey pig-metal, like those of Blaenavon and Pontypool, the volume of blast reaches as much as 280,000 cubic feet per ton of pig-metal, or 19 cubic feet per yard of capacity (·7 cubic foot per cubic foot of capacity).

(*To be continued.*)

## On Copper Refining.

By C. Stetefeldt, Mining Engineer.*

The excellent treatise of Le Play on the Welsh system of copper smelting does not contain an exact description of the copper refining process. There is also, in this respect, a deficiency in Percy's *Metallurgy*, and we look in vain for it in many other metallurgical

* From the *Berg-und Hüttenmännische Zeitung*. Nos. 22, 24, and 25, 1863.

handbooks; indeed, in Kerl's *Metallurgische Hüttenkunde* do we alone find the requisite amount of attention devoted to this subject.

This deficiency in metallurgical literature is the more surprising, as the refining of coarse or "black copper" in the reverberatory furnace is among the most interesting and difficult of metallurgical processes, and many of its attendant phenomena, which well deserve to be thoroughly determined, are not yet sufficiently explained.

The writer has had for some time the opportunity of observing the refining of copper as practised in the district of Mansfeld, and also at the Aggerthal Copper Works, near Duisburg, in Prussia. The following pages are the results of this examination: they have no claim to be exhaustive and absolutely correct, but are rather intended to excite discussion on the matter amongst those whose long and special acquaintance with copper-refining may enable them to amplify and correct the results of these observations.

I. Copper-Refining in the District of Mansfeld.—The *Berg- und Hüttenmännische Zeitung* (No. 51, 1861) contains the necessary information as to the production and composition of the "black copper" of the Mansfeld district, as also a short description of the refining furnace. It is to be remarked that at that time furnaces worked by a blast had been already long abandoned. An accurate drawing of a Mansfeld refining furnace will be found in the second edition of Kerl's *Hüttenkunde*, vol. ii, Plate VI, figs. 147 and 148.

*Description of the Process and of its attending Phenomena.**—The furnace, when at a dark red heat, is charged with 100 centners (98 cwts.) of "black copper," as well as with any waste pieces and scraps of metal from the previous melting. This operation generally takes place some hours after the termination of the previous operation, at three o'clock in the afternoon, as otherwise the hearth and arch of the furnace would be injured by the sudden lowering of the temperature caused by charging the cold metal—and also in order that the process may be finished at the same hour every day. The charging occupies about one hour, and takes four men, one of whom manages the ladles upon which the pigs of coarse copper are pushed into the furnace. The melting-down takes place with closed and luted doors and oxidation-air passages, and requires from five and a half to six and a half hours.

As soon as the hearth appears clear, and no unmelted pieces remain to be felt, the *skimming-off* of the slag takes place. The first slag formed during the melting is not sufficiently fluid to run off, but may be readily lifted off in the form of a crust, and does not stick to the scraper. After the slag has been separated, the metal is seen to smoke rather strongly—an appearance arising from the presence of zinc. The oxidation-air passages are now opened, and also the filling and working doors, if the temperature allows of it, and the *boiling* stage begins. In the neighbourhood of the air passages, the metal acquires a violent motion, and slag again quickly forms. At places where cold air has access to the surface of the metal, a development of bubbles is to be seen, accompanied by a peculiar noise. In order to further the formation of the slags, they

* The observations were made in the spring of the year 1861.

are raked together with wooden poles—even some poles are thrown into the furnace, the carbonisation of which helps to separate the metal from the slags. The slag now forming is as yet scarcely fluid, but is rather pasty.

About an hour after the beginning of the boiling stage, and after the metal has again been freed from slag, if—unless the bubbling has increased—the temperature be lowered, a very remarkable phenomenon, called *copper-rain*, takes place. Accompanied by a very loud hissing noise, thousands of little shining shots rise thickly together out of the bath of metal, and are projected on all sides up to the arch of the furnace. Nearly the whole surface of the metal is in motion, presenting the appearance of a sheet of water in a shower of rain. The copper is quite clear of slag on the places where this copper-rain is occurring, the slag being driven away by the powerful development of $SO^2$ gas. Roundish pieces of slag often acquire a rotative movement. It is to be remarked, that this appearance has its beginning at the air passages, and spreads from them further into the furnace. The slag, which is formed in smaller quantities during the copper rain than previously, is thin, and flows away at the working door. The copper rain ceases after from half to three-quarters of an hour, and is succeeded by a development of gas in large bubbles, causing the hissing* noise to be changed into a sound as of boiling or baking. This so-called "*baking*" (braten) operation occurs with the greatest intensity, with a strong ebullition of the metal, where the air has most access; the temperature being kept as low as possible, which is necessary for the occurrence of the phenomenon. At the end of this stage, waste strips of copper are generally thrown into the furnace, round each of which a very strong frothing is remarked. The strips of copper, although specifically heavier than the fluid metal, swim on the top, and the frothing continues until they are melted up. This development of gas cannot be caused by the strips of copper being damp, as the same appearance takes place when they are previously heated: it is rather to be compared to the ebullition that takes place when solid bodies are thrown into liquid saturated with gas.

When the "baking" has lasted about two hours, the metal assumes a quieter appearance, and an even, mirror-like surface; upon which the temperature is again raised. The formation of a thin quicksilver-like slag now quickly takes place, which, when drawn out, is accompanied by much clinker. If a sample be now taken, it will be remarked that it spits or rains while cooling, and then rises up. Small shots of metal are first projected into the air, after which the copper breaks through the solid surface, and forms craterlike prominences; and an odour of $SO^2$ is clearly perceptible. Samples are taken from time to time, in order to observe the progress of the process, and as soon as the copper is nearly free from other metals, and is become very dry, the poling is begun. The nearer the copper approaches being dry or refined (*gaar*), the more it rises up.

* It is usual in the Mansfeld district to call the whole operation, from the first drawing of the slag to the poling, "*baking*" (braten), but it seems more convenient to designate the first stage as *boiling*, and to reserve the expression "*baking*" especially to the phenomena above described.

A judgement is formed of the samples from :—1, the surface of the disc in the ladle, and 2, the nature of the crust on the underside of the ladle. The surface is at first black, but afterwards reddish yellow spots appear. During the rising, the crater-like elevations first show themselves, which remain isolated, and out of which a stream of copper afterwards flows which runs about the ladle, forming vermicular concretions on the surface of the sample, and a wire-like surfaced crust underneath. Characteristic changes occur on this under-surface crust. It is at first covered with large holes, connected with each other in a net-like form. The dryer the copper becomes, or the nearer it is to refined (*gaar*), the smaller become these holes, which gradually disappear. The sample, however, is not as yet quite smooth, for although the concavities are not netted together they form fine feathery marks of a purple-red colour.

As soon as this condition supervenes, which shows that the copper is dry, it is left quiet for about two hours, after which the process of *compact-poling* begins—so-called, because it puts a stop to the rising up, and makes the metal compact. A birch-pole is plunged, the thick end foremost, in at the working door, and, by its decomposition evolving an immense quantity of gases, brings the copper into a very lively state of ebullition. The air passages now remain open, in order that a further purification of the copper may be effected by scorification. The slags, which are formed in some quantity, are drawn off. It is, however, easy to be deceived as to the quantity of slag formed, as the thin quicksilver-like slag that was before present, and which is difficult to be drawn off, is cooled in the process of poling, and so become thick and visible at this stage. After some time, a trial-piece taken rises up indeed, but in a much less degree than before, for on the surface of the sample there merely rises a convexity, which, on the cooling down, is only shown by a black dot: later samples do not show any rising at all. These samples are cut with a chisel, screwed into a vice, and broken. The nature of the broken surface at this stage affords the means of judging of the progress of the process.

In what follows, the writer attempts to characterise the interesting changes which the samples undergo in the course of the process. The samples taken at the poling stage do not generally show, at the fracture, a homogenous appearance, the upper flat part differing from the under convex part. The line which physically (and perhaps also chemically) separates the two different parts of the fracture may be designated the *boundary*. The higher the proportion of $\dot{C}u$ (dioxide of copper) in the copper, the deeper is this boundary line, which rises up higher as the reduction of the $\dot{C}u$ advances by means of the poling.

After about a quarter of an hour's poling, the boundary becomes very strongly marked. The fracture of the upper part of the disc shows a fine grained texture with violet spots, but underneath the texture is more streaky, and the colour is brick-red. From the boundary to the upper surface are shining holes of the size of a pin's head, which are filled up with a fibrous network. The longer axes of these holes are, as a rule, at a right angle to the plane upper surface of the sample. As the poling is continued these holes get smaller, and

at last entirely disappear. It may at the same time be remarked, that as the boundary rises up higher, the violet colouring of the upper half is no longer visible, and the texture of the under half changes into one of a finer and more compact character.

At this stage, the workman takes out the pole, re-oxidises, and then poles again. At the end of the oxidising stage, which follows the first poling, when the copper has taken up much Ċu, the boundary line becomes very much sunken, and is sometimes indeed no longer visible. The fracture then appears of a coarsely cubical crystalline texture, and the facets of the crystals are of a violet colour. The boundary again shows itself very clearly sometime after the beginning of the second poling, and it is also raised further up. The upper part is then finely crystalline, with violet spots, but on the boundary, small shiny concavities again appear. The texture below the boundary is streaky, and network-like.

In the course of the poling, the boundary continues to rise, the fracture of the upper half becomes more delicately crystalline, the violet colouring gradually disappears, and porosities are only to be discovered by means of a magnifying glass. The boundary finally entirely disappears, and the texture becomes fine-grained, and perfectly compact. Gold coloured dots—not to be confounded with the shining cavities of the porous samples—cover the rose-red fracture, which shows a silky lustre when held in a side-light.

A very peculiar appearance is sometimes to be seen at this period. The samples are to a great degree compact, but they contain here and there fissures of different sizes, of a splendid golden-yellow colour, possessing a very beautiful needle-shaped, netted texture, and standing out in sharp contrast with the rose-red ground. When the sample is cooled down, these fissures are easily perceivable from the outside, and the discs broken at them. When such fissures appear, it is necessary to get rid of them by repeated oxidising and poling. The rabble is worked to and fro at the bottom of the hearth, and the metal is again oxidised. It is now observed that the copper takes up the Ċu very slowly, that the boundary does not again show itself, and that the poling causes the fissures entirely to disappear.

As soon as the samples show a fine-grained streaky texture, many golden dots, a silky lustre in a side-light, and a beautiful rose-red colour, the workman withdraws the pole, closes the air-passages, covers the metal with charcoal, closes the working door, and leaves the furnace quiet for an hour, in order that it may recover its heat, as in the poling the copper has become much cooled.

In order that any Ċu still present may be got rid of, what is called the *tough-poling* is then begun. The samples taken at this stage are very difficult, indeed scarcely possible, to break. Their points of difference are very slight, and, indeed, difficult to describe. The texture is fine and fibrous (*hakig*), with gold-coloured dots, and the colour is lighter, and the silky lustre more marked. The condition of the surface of the trial-piece tolerably clearly indicates the progress of the toughening; for concentric rings are formed on the surface, whose number increases in proportion to the toughness of the copper.

The art of the refiner consists in being able accurately to recog-

nise when the copper has arrived at this condition of maximum toughness (tough-pitch). If the copper be over-poled, even ever so little, a product is obtained which cannot be used for finer work, and which is rather red-short than cold-short. Copper very much over-poled is useless for ordinary purposes. At the fracture, this copper has a peculiar yellowish-red colour, and after extreme over-poling it becomes grey. It is the opinion of most smelters that such copper has taken up carbon.

During the tapping, hammer trial-pieces are taken. These are hammered out into a thin plate, and into rectangular rods, which must be capable of being bent without cracking. As the tapping lasts for a long time, during which the copper might again take up $\dot{C}u$, or be changed by contact with the carbon, trial-pieces must still be taken.

As it is at last impossible to pole the small quantity of copper remaining in the hearth, this metal, as it contains $\dot{C}u$, is cast into special moulds, for the manufacture of brass. After the hearth has been cleaned and repaired with quartz sand, the fire is allowed to go out, all the doors are closed, and the furnace is left to cool down until the beginning of the next charge.

From 100 centners (98 cwts.) of "black copper," containing on an average 94 % of Cu, there is produced 85·5 centners of refined copper, and 19·75 centners of refinery slag, containing from 35 to 75 % of Cu. Analyses of the refined copper and refinery slag, made at various stages of the process, will be found in No. 51 (1861) of the *Berg- und Hütten. Zeit.* before referred to. The consumption of charcoal for each charge amounts to from 40 to 42 *tonnen* (60½ to 63½ bushels) of hard charcoal, and 3 *tonnen* (4½ bushels) of soft charcoal.

II. Copper Refining at the Aggerthal Works, near Duisburg.*—The refining furnace is of the ordinary form, fed with coal, and, similar to the one at Mansfeld, has oxidation-air passages.

The "black copper," of from 95 to 97 % of Cu, is obtained by the English method of smelting (by reverberatory furnaces) from American oxidised ores, and Rhenish and Norwegian siliceous ores (Kerl's *Metallurgische Hüttenkunde*, 2nd Ed., vol. ii, p. 509). On being drawn from the furnace and allowed to cool, it rises up very much and evolves enormous quantities of $SO^2$. At the fracture it shows a tolerably high proportion of $\dot{C}u$, and is intersected by many concavities of a brilliant gold colour.

*Description of the Mode of Working and the accompanying Phenomena.*—About an hour after the charging of from 50 to 60 centners of "black copper" the doors and air passages are closed and luted up; the latter being opened as soon as the copper has attained a red heat. The pieces are gradually melted down at a moderate temperature, which process is termed "roasting."

When the greater part of the copper is *melted down*—during which slag is formed in large quantities—a peculiar noise is perceived in the air passages, and a considerable development of bubbles is

* The writer visited the Aggerthal Copper Works in the month of May, 1862.

remarked in the slag. When no more unmelted pieces can be felt in the fluid copper, the air passages are closed, and the temperature is raised as high as possible in order to bring the metal into a perfectly fluid state. About nine hours are required for the roasting and melting down.

When the hearth is clear the workman draws off the pasty slag, which is already coloured red from the high proportion of Ċu it contains, opens the oxidation-air passages, and the boiling stage commences. The slag now formed is little altered in appearance, but is more fluid. After the first slag has been drawn off, the surface of the metal is perfectly clear and undisturbed. A sample taken out rises up in the ladle; the surface, however, remaining unbroken, although a large bubble is formed. That part of the trial-piece under the bubble is penetrated by many holes of a bright golden colour. The under part of the trial-piece is of a dirty red colour, and has a tolerably smooth surface.

The high temperature produced during the melting down is now allowed to fall so far that the workman can see in through the working door as far as the fire-place. The metal now immediately begins to be agitated (*es arbeitet*, it works), and the same phenomenon occurs that in the Mansfeld district is called "*braten.*" The duration of this process varies considerably, depending upon the height to which the copper in the furnace has been worked up in the process of making it into "black copper." After this working has finished, an increased temperature is again necessary. During that process very little slag was formed, but later on it is formed more abundantly. In the course of the boiling, which lasts about six hours, the character of the samples undergoes the following changes:—The appearance of the disc in the ladle remains unaltered, but the under side is intersected by holes, and changes as is shown in the foregoing description. At a later stage the trial-pieces rise up with much greater force, so that the upper crust is broken through, and copper runs out. The fracture of the entire sample is full of bubbles; but the cavities no longer appear a bright gold, but assume a dirty red colour; the surface of the trial-piece on the ladle is however smooth. In the Mansfeld district, the compact poling now begins.

The assays rise up less and become more compact in proportion as the oxidation progresses, but the cavities again assume a bright golden appearance. When the crystalline texture—so characteristic of a high percentage of Ċu—distinctly appears, the sides of the cavities have a shining white appearance. As soon as the samples assume a coarsely cubical crystalline texture, and only show small holes with violet walls and fissures on the upper surface, the boiling stage is finished.

Before proceeding to the poling, some pounds of lead are mixed with the copper in order to improve its quality, which is also done in England with inferior descriptions of copper.

The *poling* is now at once proceeded with, with closed air passages, and the metal is covered with charcoal. In general, as the reduction of the Ċu progresses, the trial-pieces assume a finer crystalline texture, but never show any boundary line such as we have seen is the case in the Mansfeld district. The cavities are at first

shining white, but later on assume a bright golden appearance. When the fracture is streaky, and of a bright brick red, the poling is discontinued. The charcoal and slag are drawn off, and the copper is again allowed to get very hot, and somewhat oxidised, but without opening the air passages. This is indispensably necessary, and must be continued for a longer time if the sample has a streaky texture and is not yet perfectly compact. When the poling is continued, the trial-piece assumes the changes described when referring to the Mansfeld process. The texture becomes fibrous, and gold-coloured dots make their appearance. When the copper is considered to be tough-pitch, two bars, each about an inch thick, are cast—one of which is bent cold, the other hot, by the hammer, and neither of which must show any cracks. On the cold bar being broken, it can be seen, by the large fracture, whether $\dot{C}u$ is still present; whether the copper is over-poled; or whether it is not yet quite compact. When the copper is red-short, it is best to oxidise and pole over again.

(*To be continued.*)

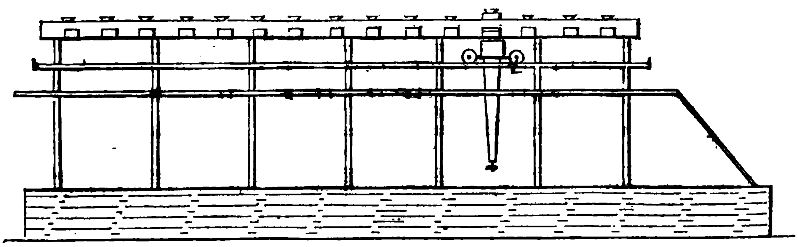
## Apparatus for Washing Out Slime-Pits.

ARRANGED BY CAPTAIN RICHARD PEARCE, OF DOLCOATH MINE, CAMBORNE.

In no metallic ore is mechanical preparation, or "dressing," pushed so far as in the case of the tin ores of Cornwall. Speaking in round numbers, there is at present returned in that county about 1,000 tons of black tin monthly—to produce which, fully 60,000 tons of tin stone, or tin ore, have to be stamped down to a fine powder, and subsequently submitted to a complicated series of manipulations. In its rough state the average value of the tin stone raised in the county can scarcely exceed, if indeed it reaches, 1*l.* per ton; while at present prices, dressed ore, or black tin, may be taken at 70*l.* per ton. In the case of no other metal is there such a wide difference between the relative value of the rough and prepared ore. So that tin-

FIG. 1.

SIDE ELEVATION OF APPARATUS. (Scale: 8 feet to 1 inch.)

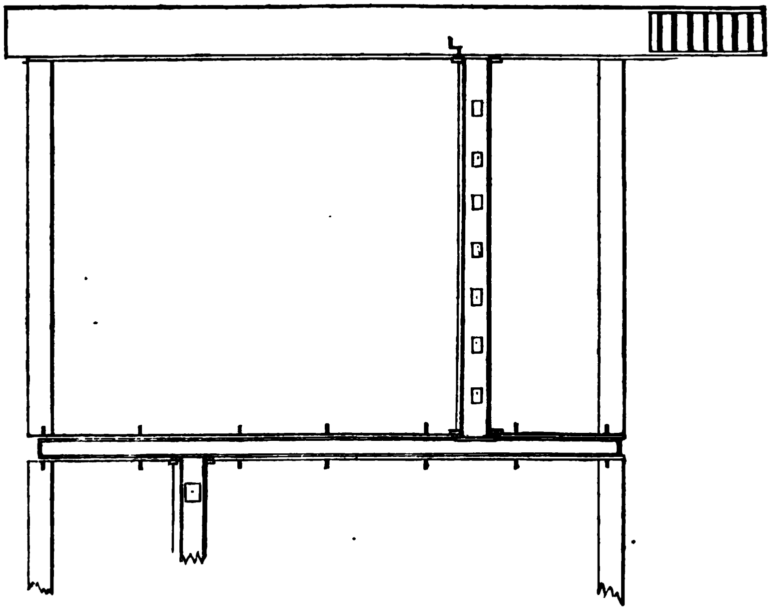


dressing in Cornwall may be taken as the most perfect type of what is to be effected in the mechanical preparation of metallic ores.

The improvements which have taken place in tin-dressing during the last fifteen or twenty years have been, in their results, as propor-

FIG. 2.

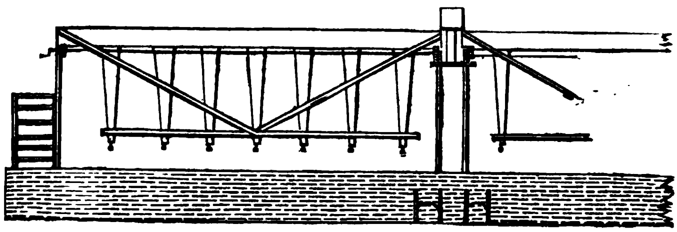
PLAN OF APPARATUS. (Scale: 8 feet to 1 inch.)



tionately valuable in their kind as the improvements effected by Watt in the steam-engine. Indeed, under the old system of dressing, it would have been simply impossible to have worked to a profit a large proportion of the ores now returned in Cornwall. The most valuable improvements, however, are of such a nature as not to be

FIG. 3.

SIDE ELEVATION OF APPARATUS. (Scale: 8 feet to 1 inch.)

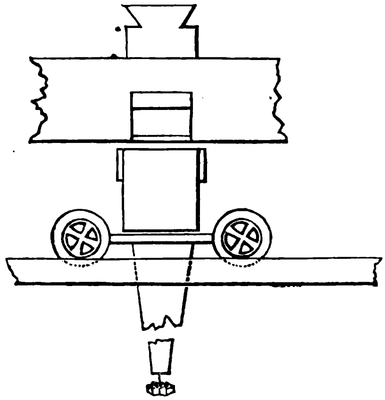


very conspicuous; they are generally mere savers of labour, and present none of those striking features which enable certain inventions to be popularised, and appreciated even by those least acquainted with the subjects with which they are connected. Indeed the most

valuable improvements in tin-dressing, of late years, have been mere arrangements by which labour has been economised.

FIG. 4.

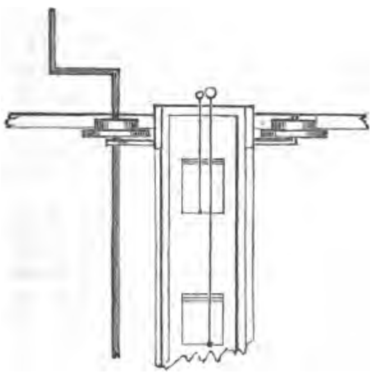
ENLARGED SIDE ELEVATION, SHOWING END OF TRANSVERSE TRAVELLING LAUNDER. (Scale: 2 feet to 1 inch.)



Among these latter we may class Captain Pearce's apparatus for washing out slime-pits, which has recently been erected by him at Dolcoath, and has since been adopted at some of the neighbouring tin mines of that great district. The accompanying figs. 1, 2, and 3, on a scale of 8 feet to 1 inch, and figs. 4, 5, 6, on the enlarged scale of 2 feet to 1 inch, show the arrangement of this apparatus. It

FIG. 5.

ENLARGED PLAN, SHOWING END OF TRANSVERSE TRAVELLING LAUNDER WITH CLACK. (Scale: 2 feet to 1 inch.)

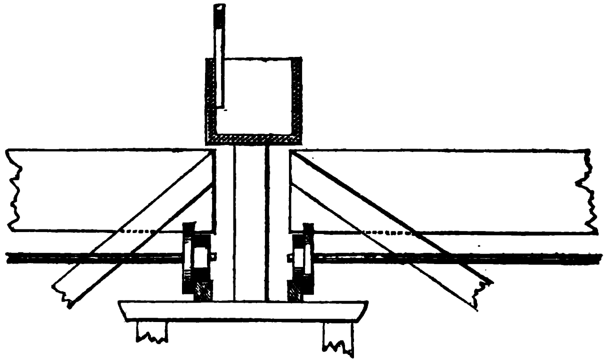


consists essentially of a transverse travelling launder, arranged across the breadth of the pit, at an elevation above it of about 6'. This travelling launder is provided with any required number of downright pipes (seven is the number shown in the drawings given), each about 4' long; and is supplied with water by a main longi-

tudinal launder, running the length of the pit, and in which there are flushets at regular distances, so as to supply the travelling launder at any required position of its course. This transverse launder travels on iron wheels, on a roadway of two wooden rails, being moved as required by the handle shown in the drawing. The mouth of each of the downright pipes is fitted with a clack, regulated by a wire, by which the supply of water for flushing the pit is controlled; and to the bottom of each a wooden button is attached, for the purpose of scattering the stream of water falling through it.

FIG. 6.

ENLARGED SECTION ACROSS MAIN LONGITUDINAL LAUNDER, SHOWING ENDS OF TWO TRANSVERSE TRAVELLING LAUNDERS. (Scale: 2 feet to 1 inch.)



The drawings sufficiently explain themselves for any long written description to be unnecessary. The travelling launder is brought to any convenient part of the pit, and being supplied with water by the corresponding flushet in the main launder, this water is directed, by means of the clacks, into any of the required downright pipes. The buttons at the bottoms of these scatter the water, which breaks up and carries away the slime with the greatest rapidity, without the aid of any of the usual auxiliary labour. Of course the transverse launder usually commences clearing out the lower part of the pit, and progresses upwards. When there are a great many pits, as in the case in large mines, it is usual to connect two transverse launders with one main central longitudinal launder—one on each side of it—as shown in figs. 2 and 3.

The economy of this apparatus is beyond all question. One very small boy can attend to almost any number, while formerly two big boys were required for each pit. The pits, besides, can be cleared out with absolute punctuality in the time allotted—two days; while formerly this was uncertain, and the boys had sometimes to work overtime.

The construction of the apparatus is evidently very inexpensive; and though to those unacquainted with the subject, its object may seem trifling, we can assure them that such is not really the case, and that this apparatus, simple as it is, is not the least of the improvements introduced by Captain Pearce on the floors of Dolcoath—the most extensive dressing floors in the world.

# Abstracts and Reviews.

## THE *ANNALES DES MINES.*

*Annales des Mines, ou Recueil de Mémoires sur l'Exploitation des Mines, et sur les Sciences et les Arts qui s'y rapportent.* Rédigées par les Ingénieurs des Mines, et publiées sous l'Autorisation du Ministre des Travaux Publics. Sixième Série. Tome II. 4e et 5e livraisons de 1863. Paris: Dunod, Quai des Augustins.

The two livraisons of the *Annales des Mines* contain the following papers, none of which are of special interest to our readers, except that by M. Moissenet on the lodes of Cornwall and Devonshire, which we noticed in our last number.

Notice sur les Sources Thermales de Bourbonne-les-Bains, par M. Drouot.

Note sur un Système de Bagues en Fonte applicable à la Voie Vignole, par M. Desbrière.

Etudes sur les Filons du Cornwall et du Devonshire, par M. L. Moissenet.

Mémoire sur l'Exposition de Londres et le Matériel d'Exploitation des Railways Anglais en 1862, par M. J. Gaudry.

Théorie du Compresseur à Colonne d'Eau de MM. Sommeiller, Grattoni et Grandis, et Application au Compresseur qui fonctionne au Percement des Alpes Cottiennes, par P. de Saint-Robert.

Note sur les Fours à Cuve à Section rectangulaire ou ovale, par M. L. Gruner.

Note sur l'Appareil employé en Angleterre par le Post-Office pour l'Exchange des Dépêches sans Arrêt des Trains, par M. J. Morandière.

## THE *REVUÊ UNIVERSELLE.*

*Revue Universelle des Mines, de la Métallurgie, des Travaux Publics, des Sciences et des Arts, appliquês à l'Industrie,* sous la direction de M. Ch. de Cuyper, Professeur Ordinaire à la Faculté des Sciences de l'Université de Liège. Seventh year, 2nd livraison, March and April, 1863. Paris and Liège, Noblet et Baudry à Paris, rue Jacob, No. 20.

There are five principal articles in this number of the *Revue Universelle:*—

1. Métallurgie du Plomb, par Michel Cahen (concluded from the last number).
2. De la Fabrication de la Tôle, par Oscar Rougé (concluded from the last number).
3. Mémoire sur la mine de Plomb et de Zinc de Pontpéan, par Joseph Fayn.
4. Note sur le Laminoir universel des Forges de Wittkowitz, par S. Jordan.
5. Notice sur l'Acier Bessemer, par F. Krans.

M. Cahen's memoir, which was crowned by the Liège Association of Engineers, will be found a very exhaustive one on the metallurgy of lead as practised on the Continent, bringing the information to a very recent date, as also a considerable amount of information on English lead-smelting; but, as might be expected, the memoir is more valuable from the information it gives of the Continental methods.

The other papers are also full of valuable information; that on the mines of Pontpéan, containing very full particulars on the lead dressing operations practised in Brittany. M. Krans' notice on Bessemer steel is founded on the information collected on a visit to Sheffield in September last. It is full of interest as the expression of opinion of an impartial

competent observer. M. Krans thinks very highly of the process, and has great confidence in its future, although he thinks that there are still some difficulties to be overcome; and he particularly recommends the application of tungstane for improving the inferior qualities of the new steel.

## EAST INDIA COAL FIELDS.

Dr. McClelland's *Report on the Coal Fields of India* has just been printed as a parliamentary paper. As the date of the report is as far back as 11th July, 1845, it can of course afford us no new information—and has in many respects been necessarily superseded by the more recent reports of Professor Oldham and other members of the Geological Survey of India. Much of the information is, however, new to English readers, and the whole is an important contribution to the history of the discovery of coal in India. Dr. McClelland, who was then an assistant-surgeon in the Bengal Medical Service, acted for a considerable period as Secretary to the Committee for the Investigation of the Coal and Mining Resources of India, and a large proportion of the present report is made up of abstracts of the minutes of the proceedings of this committee from May, 1839, to April, 1842. The report is accompanied by twelve plates, principally maps of the coal localities, and is also illustrated by several sketches showing sections of the coal fields—and on the whole will be found to contain much matter worthy of the notice of those interested in the Indian coal field, or, indeed, in the development of the new coal fields in any of our colonial dependencies.

## THE BOARD OF TRADE RETURNS.

The "Accounts relating to Trade and Navigation of the United Kingdom, for the month ended 31st May, 1863, and five months ended 31st May, 1863," have been issued by the Statistical Department, Board of Trade.

IMPORTS.—The quantities and relative increase and decrease of the imports of metals, metallic ores, and mineral products, for the month and five months ended 31st May, have been as follows:—

| | Month ended 31st May. | | | Five Months ended 31st May. | | |
|---|---|---|---|---|---|---|
| | 1862. | 1863. | Increase (+) or Decrease (−) | 1862. | 1863. | Increase (+) or Decrease (−). |
| Brimstone ... ... cwt. | 127,891 | 15,744 | −112,147 | 402,806 | 295,352 | −107,454 |
| Copper Ore ... ... tons | 7,997 | 9,611 | + 1,614 | 35,809 | 33,084 | − 2,725 |
| Copper Regulus ... ... „ | 1,392 | 1,640 | + 248 | 12,117 | 9,743 | − 2,374 |
| Copper, unwrought and part wrought ... cwt. | 26,180 | 20,580 | − 5,600 | 111,060 | 83,140 | − 27,920 |
| Iron, in Bars, unwrought tons | 2,597 | 2,994 | + 397 | 4,433 | 6,575 | + 2,142 |
| Steel, unwrought ... „ | 357 | 93 | − 264 | 1,843 | 561 | − 1,282 |
| Lead, Pig and Sheet ... „ | 2,158 | 2,059 | − 99 | 7,023 | 8,972 | + 1,949 |
| Spelter or Zinc ... ... „ | 1,143 | 2,724 | + 1,581 | 3,728 | 8,854 | + 5,126 |
| Tin, in Blocks, Ingots, Bars, or Slabs ... cwt. | 8,843 | 2,620 | − 6,223 | 33,238 | 14,227 | − 19,011 |
| Silver Ore... ... value in £ | 5,560 | 25,410 | + 19,850 | 123,344 | 139,223 | + 15,879 |
| Petroleum ... ...tuns | 3,305 | 3,864 | + 559 | 6,695 | 15,670 | + 8,975 |
| Quicksilver ... ... lbs. | 42,023 | 43,295 | + 1,506 | 124,754 | 401,627 | +276,873 |

EXPORTS.—The quantities, declared value, and relative increase and decrease of the exports of metals, minerals, and metallurgical articles of British and Irish produce and manufactures, for the month and five months ended 31st May, have been as follows:—

| | QUANTITIES. | | | | DECLARED VALUE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Month ended 31st May. | | Five Months ended 31st May. | | Month ended 31st May. | | | Five Months ended 31st May. | | |
| | 1862. | 1863. | 1862. | 1863. | 1862. | 1863. | Increase (+) or Decrease (—) | 1862. | 1863. | Increase (+) or Decrease (—) |
| | | | | | £ | £ | £ | £ | £ | £ |
| Alkali: Soda ... ... ... cwt. | 198,543 | 173,358 | 831,551 | 886,288 | 84,379 | 74,268 | — 10,111 | 343,079 | 370,548 | + 27,469 |
| Coal, Cinders, and Culm ... ... tons | 775,208 | 694,975 | 3,190,928 | 3,168,269 | 348,041 | 305,760 | — 42,281 | 1,440,256 | 1,417,087 | — 23,169 |
| Iron, Pig and Puddled ... ... " | 49,756 | 48,827 | 183,709 | 188,745 | 133,919 | 131,118 | — 2,801 | 494,151 | 516,937 | + 22,786 |
| Iron, Bar, Angle, Bolt, and Rod... " | 28,707 | 27,759 | 118,386 | 131,672 | 212,087 | 211,197 | — 890 | 849,974 | 976,973 | + 126,999 |
| Iron, Railroad, of all sorts ... " | 44,542 | 37,093 | 143,197 | 161,348 | 329,514 | 276,435 | — 53,079 | 1,038,936 | 1,152,962 | + 114,026 |
| Iron Wire, except Telegraphic.... " | 1,109 | 2,114 | 3,782 | 8,928 | 24,359 | 38,633 | + 14,274 | 91,759 | 178,816 | + 87,057 |
| Iron, Cast ... ... ... ... tons | 7,679 | 7,081 | 24,253 | 34,190 | 62,827 | 60,014 | — 2,813 | 220,369 | 290,119 | + 69,750 |
| Iron Hoops, Sheets, and Boiler Plates ... ... ... " | 9,930 | 11,545 | 35,437 | 51,048 | 99,744 | 132,689 | + 32,945 | 351,548 | 573,964 | + 222,416 |
| Iron, wrought, of all sorts ... " | 9,836 | 10,187 | 37,658 | 43,208 | 187,352 | 197,420 | + 10,068 | 751,549 | 814,316 | + 62,767 |
| Iron, old, for re-manufacture ... " | 4,322 | 1,986 | 8,767 | 9,004 | 17,235 | 8,536 | — 8,699 | 34,493 | 33,164 | — 1,329 |
| Iron Steel, unwrought ... ... " | 2,553 | 2,493 | 10,186 | 11,016 | 83,998 | 85,939 | + 1,941 | 342,292 | 353,896 | + 11,604 |
| Copper, unwrought, in Ingots, Cakes, or Slabs ... ... cwt. | 4,298 | 29,924 | 37,561 | 106,947 | 21,312 | 135,771 | + 114,459 | 188,128 | 488,093 | + 299,965 |
| Copper, wrought or partly wrought, Bars, Rods, Bottoms, Pans, Plates, Sheets, and Nails; and mixed or Yellow Metal for Sheathing .. " | 36,946 | 51,168 | 159,225 | 216,683 | 166,406 | 228,421 | + 62,015 | 755,709 | 986,975 | + 231,266 |
| Copper, wrought, of other sorts... " | 2,988 | 849 | 10,602 | 3,874 | 18,009 | 4,800 | — 13,209 | 67,367 | 23,089 | — 44,278 |
| Brass of all sorts ... ... " | 3,432 | 4,644 | 14,295 | 16,932 | 18,132 | 23,733 | + 5,601 | 77,989 | 84,552 | + 6,563 |
| Lead, Pig, Rolled, Sheet, Piping, Tubing, and Lead Shot tons | 3,722 | 4,228 | 11,454 | 16,007 | 78,017 | 90,177 | + 12,160 | 244,594 | 346,208 | + 101,614 |
| Lead Ore, Lead, Red and White, and Litharge of Lead ... " | 939 | 650 | 3,684 | 2,766 | 19,732 | 15,441 | — 4,291 | 81,277 | 65,722 | — 15,555 |
| Salt ... ... ... ... ... " | 77,470 | 70,796 | 250,858 | 262,416 | 35,283 | 33,613 | — 1,670 | 118,229 | 118,795 | + 566 |
| Tin, unwrought ... ... ... cwt. | 11,406 | 5,662 | 83,817 | 28,633 | 66,305 | 33,387 | — 32,918 | 200,192 | 167,684 | — 32,508 |
| Tin Plates ... ... ... ... " | 94,790 | 86,159 | 432,792 | 460,780 | 115,224 | 102,628 | — 12,596 | 514,850 | 538,577 | + 23,727 |
| Zinc or Spelter, wrought or unwrought ... ... ... " | 4,479 | 8,585 | 43,598 | 35,910 | 4,483 | 8,174 | + 3,691 | 42,562 | 35,174 | — 7,388 |
| | | | | £ | 2,126,358 | 2,198,154 | + 71,796 | 8,249,303 | 9,533,651 | +1,284,348 |

## THE DISCOVERY OF THALLIUM.

A letter from Mr. Crookes has appeared in the July number of the *Philosophical Magazine* in reply to certain accusations made against him by M. Lamy in reference to this subject.

Mr. Crookes commences by stating that he would have gladly abstained from controversy as to the mere question of priority in the discovery, or in the publication of the discovery; but the purport of some of the statements made by M. Lamy's recent memoir in the *Annales de Chimie et de Physique* is of such a nature that he finds it necessary, for his own credit, to show these accusations to be unfounded.

He then proceeds to recapitulate all the circumstances attending the publication of his discovery, which may be stated succinctly as follows:—

1. In April 1861 he contributed to the *Philosophical Magazine* a paper, "On the Existence of a new Element, probably of the Sulphur Group," and May 18th, in the *Chemical News*, "Further Remarks on the supposed New Metalloid."

2. At this time, consequently, Mr. Crookes was admittedly unaware of the metallic nature of the element. Having, however, directed his attention exclusively to elucidating its chemical history during the subsequent months, he states that he succeeded in obtaining it in its metallic state in the following January: he must at all events have done this before the end of April, 1862—for on the 1st of May there was displayed at the opening of the International Exhibition a case containing specimens stated to consist of the metal itself, of its oxide, and of its sulphide, which case was labelled "*Thallium, a new metallic element . . . . appears to have the character of a heavy metal, &c.*" Mr. Crookes states that it was his intention to have exhibited a large series of specimens, but, not having been able to meet with any abundant source of thallium, he was unable to provide more than the three portions stated from his scanty store.

3. On the 7th of June following he learnt that M. Lamy had been at the Exhibition and shown there an ingot of thallium; and that upon being taken to Mr. Crookes' case, and having had the labels translated to him, he remarked that the substance exhibited there as thallium was not the metal but its sulphide.

4. Two days afterwards Messrs. Crookes and Lamy were introduced to each other at Dr. Hofmann's house; when the former was shown the ingot of thallium. According to Mr. Crookes, however, their intercourse on this occasion was confined to a few complimentary phrases, since M. Lamy could not speak a word of English and Mr. Crookes' power of conversing in the French language was almost equally limited. What occurred at this meeting is of great importance, for M. Lamy insinuates that Mr. Crookes on this occasion first learned from him that thallium was a metal, and that having done so he hastened to communicate the fact to the Royal Society as a discovery of his own.

5. This, of course, Mr. Crookes indignantly denies. But he admits, that having found that M. Lamy was working diligently on the subject, he considered it necessary at once to take steps to make known the results he had already obtained, without waiting, as he had intended, until the investigation was completed.

6. With this view he wrote at once a private note to Dr. Miller, stating that he had worked for many months on the subject, and had indeed nearly finished a "Preliminary Note on Thallium," which he was going to send to the Royal Society in a week or so. He told the Dr. that, not suspecting anyone else was working on the subject, he had purposely avoided publishing anywhere else any of his recent results, so as to give the Royal Society paper more importance. He proceeded to express his dismay at finding that M. Lamy had been pursuing the same object; and that, from the larger quantity of material at his disposal, he had probably

been able to anticipate all his results, if not go beyond them. He stated that he had understood that M. Lamy had sent in a memoir to the Society at Lille; and under the circumstances he asked Dr. Miller what he had better do—whether he should send in his imperfect note or not? Dr. Miller at once replied, recommending him to send in his note "*at once* by all means."

7. In pursuance of this advice Mr. Crookes sent to the Royal Society a statement of the results he had already arrived at, under the title "Preliminary Researches on Thallium,"* which was read on the 19th June, 1862. On the 16th May, 1862, M. Lamy made a communication to the Société Impériale at Lille, in which he also described thallium as a metal, and, referring to Mr. Crookes' papers of 1861, stated that the black powder, which the latter regarded as thallium, was nothing but the sulphide of thallium. On his own showing, M. Lamy did not discover the green band of thallium until April, 1862; and he does not claim to have isolated the metal until the interval between the 2nd and the 16th of May, on which latter date he first exhibited it at Lille.

These are the facts of the case, from which the following results may be deduced. It is admitted on all hands that on the 30th March, 1861, Mr. Crookes announced the existence of a new elementary substance, which he then (incorrectly) supposed to be a metalloid of the Sulphur Group. He is, therefore, incontrovertibly entitled to be regarded as the first discoverer of the *existence* of thallium, for M. Lamy does not claim to have noticed the green band for thirteen months afterwards.

The real question in dispute is—Who first ascertained the true metallic nature of the element? It is admitted that at first Mr. Crookes took an incorrect view in this respect; and also that M. Lamy exhibited thallium in its metallic form at Lille, on the 16th May, 1862. It remains, therefore, for Mr. Crookes to show that, during the year that intervened between the appearance of his paper in the *Chemical News* on May the 18th, 1861, and the exhibition of thallium in its metallic state by M. Lamy, at Lille, on the 16th of May, 1862, he had ascertained and published the true metallic nature of the element.

It seems to us that Mr. Crookes does prove this beyond all doubt, by the label which he displayed attached to his case at the opening of the International Exhibition on the 1st of May, 1862, where the thallium is described as a "*metallic element*" having "*the character of a heavy metal*," and as being reducible "*from its acid solutions by zinc, in the form of a dense black powder.*"

MM. Lamy and Dumas refuse to recognise this evidence, and maintain that the substance Mr. Crookes exhibited "was not thallium, and could not be thallium," but only a black powder to which he gave that name. But the force of this objection, even if it were true, is not by any means obvious; for if Mr. Crookes had at any time publicly stated in writing that he had ascertained the element thallium to be a metal, his claim as being the discoverer of this fact would undoubtedly rank from the date of that statement. It would be no answer to this claim for a person, subsequently publishing the fact, to assert that the first publisher of it had not really made the discovery that he stated he had made. Consequently, under any circumstances, M. Lamy's objection to Mr. Crookes' claim seems to be wholly untenable.

But M. Lamy really seems to have no ground whatever for his statement that the powder exhibited was not metallic thallium. He imagines that the powder was a sulphide, precipitated with sulphuretted hydrogen; but there seems no possible reason for supposing that it may not as well

* We have reprinted this memoir in vol. ii, pp. 297, 356, and vol. iii, p. 35. —Ed. M. & S. M.

have been metallic thallium, precipitated in powder by zinc, which it is absolutely described to be on the label attached. Mr. Crookes maintains this not only to have been the case, but he also states that he obtained thallium in a melted metallic state as far back as January, 1862.

If M. Lamy and his friends, however, had been merely satisfied to endeavour to throw doubt on Mr. Crookes having first discovered the true metallic nature of thallium, we might have been content to allow them to enjoy whatever satisfaction they may derive from such cavils. But M. Lamy goes much further and gratuitously attributes to Mr. Crookes a most dishonest and dishonourable proceeding. He says that this gentleman first learned from him, at their interview at Dr. Hofmann's on the 9th of June, that thallium was a metal; and that having learned this he hastened to communicate it to the Royal Society as his own discovery.

When a person makes so scandalous a charge as this, it might be expected that some plausible grounds would at least be forthcoming to sustain it. But M. Lamy really puts forward none, except his opinion that the powder exhibited "could not be thallium"—an opinion which, even if it were well founded, could not in the least degree shake Mr. Crookes' claim to be ranked as a prior discoverer, by virtue of his public statement on May 1st, 1862, that thallium was a "metallic element." Besides this statement however—and Mr. Crookes' positive assurances that he had long previously discovered the metallic character of the element—there is the strongest probability of such being the case. Indeed, as he points out, it would have been almost impossible for a chemist, working almost daily for twelve months on thallium, to have failed to discover its metallic nature—as it is an element as easily reduced to, and preserved in, a metallic state as lead.

It is much to be regretted that, in a spirit of national partisanship, M. Lamy and his friends should thus seek to inflict so grave an injustice on Mr. Crookes. It may be admitted on all hands that M. Lamy has done good service in elucidating the properties of thallium; but it cannot be forgotten that these results were greatly facilitated by the abundant quantity of material which his peculiar position placed at his disposal, and which could not have been accessible to the ordinary scientific chemists working in London or Paris. M. Lamy was the first to isolate metallic thallium in abundant quantities, and this is a credit which no one in this country would be inclined to grudge him. We have no inclination to disparage his work by dwelling upon the abundant materials at his disposal; but in justice to our own countryman we must beg it to be borne in mind that all through his experiments Mr. Crookes laboured under immense disadvantages from the small amount of material at his disposal. If this had been as abundant with him as with M. Lamy, we think there can be little doubt that his case at the International Exhibition would have been adorned with a fine ingot of metallic thallium.

## M. MOISSENET ON THE CORNISH METHODS OF DRAWING STUFF.

*De l'Extraction dans les Mines du Cornwall. Puits inclinés et coudés.* Par M. L. Moissenet, Ingénieur des Mines. Paris: Dunod, Quai des Augustins, No. 49.

(*Continued from page* 23.)

### Second Part.

### § 1. *Particulars and Comparison of yearly Cost at several Mines.*

Having described the principal appliances at present employed in drawing, it becomes advisable to examine the cost of the various methods, which I shall do by describing the working at the following mines:—

1. *Dolcoath.*—Kibbles with chains, in inclined and elbowed shafts ;
2. *United Mines.*—Skips with flat-ropes, in a vertical shaft ;
3. *Levant.*—Skips with flat and wire-ropes, in an elbowed shaft ;
4. *Carn Brea.*—Kibbles with chains, and skips with flat and wire-ropes, in various kinds of shafts.

As in each case the particulars of the cost extend over a period of twelve months, they afford us all the necessary data for a subsequent discussion of their merits ; so that, with a few other special examples, we shall be in a position to consider the consumption and effective power of the engines—the amount of labour necessary—and finally to ascertain the respective advantages and inconveniences of the various methods. I have in every instance scrupulously followed the prices of material and labour that were given to me ; but it will be remarked that these differ sensibly in the various mines, and at the various periods.

I. DOLCOATH MINE.—Captain Charles Thomas, manager of Dolcoath, has favoured me with a comparative statement of the drawing in 1855 between two shafts at that mine, and a guided shaft at the United Mines.

In 1855, 20,166 tons were drawn by two shafts from an average depth of 250 fms. The shafts are vertical for one-third of their depth, and afterwards underlie from 1′ to 2′ 6″ per fm. The kibbles weigh 3 cwts., and are loaded with nearly 7 cwts. ; the chains used are $\frac{11}{16}''$ and $\frac{1}{2}''$ combined. The consumption and cost were :—

*In the Shaft.*

| | Tons | cwts. | £ | s. |
|---|---|---|---|---|
| Chain .. .. | 12 | 16 | 275 | 14 |
| Kibbles .. .. | 7 | 15 | 180 | 7 |
| Repairs and maintenance of shaft, timbering .. | | | 360 | 0 |
| | | | 816 | 1 |

*At the Engines.*

| | Tons. | £ | s. |
|---|---|---|---|
| Coal .. .. .. | 547 | 464 | 0 |
| Grease, oil, hemp .. .. | | 27 | 12 |
| Engine-men .. .. .. | | 226 | 16 |
| | | 718 | 8 |

*Filling and Landing*, 12 men, 6 in the shaft .. .. £ 400

The total cost was therefore 1,934*l.* 9*s.*, for the 20,166 tons, showing a cost of 1*s.* 11*d.* *per ton* for drawing from a depth of 250 fms. Distributing these details of cost at per ton raised 250 fms., and 100 fms., and finding their percentage to the total, we have :—

| DOLCOATH. Nature of Cost. | Cost per Ton per— 250 Fathoms. Details. | 250 Fathoms. Partial Totals. | 100 Fathoms. Details. | 100 Fathoms. Partial Totals. | Percentage of Total. Details. | Percentage of Total. Partial Totals. |
|---|---|---|---|---|---|---|
| | d. | d. | d. | d. | | |
| In Shaft :— | | | | | | |
| Chain .. .. | 3·28 | 9·71 | 1·31 | 3·88 | 14·2 | 42·2 |
| Kibbles .. .. | 2·15 | | ·86 | | 9·3 | |
| Repairs, &c. .. | 4·28 | | 1·71 | | 18·7 | |
| At Engines :— | | | | | | |
| Coal .. .. | 5·52 | 8·55 | 2·21 | 3·42 | 24·0 | 37·2 |
| Grease, &c. .. | ·33 | | ·13 | | 1·4 | |
| Engine-men .. | 2·70 | | 1·08 | | 11·8 | |
| Filling and Landing.. | 4·76 | 4·76 | 1·90 | 1·90 | 20·6 | 20·6 |
| Totals .. | 23·02 | 23·02 | 9·20 | 9·20 | 100·0 | 100·0 |

Since 1855, the cost of drawing at Dolcoath has been progressively lessened. In 1858, from verbal information received, it had been already reduced to 1*s.* 10*d.* for raising 1 ton from the same average depth of 250 fms.; but it was expected that this would be reduced to 1*s.* 9*d.*, by the adoption of large 10 cwts. kibbles. In 1860, for a depth of 260 fms., by using combined ⅝″ and ½″ chain it was reduced to 1*s.* 6½*d.* During this same year, the cost at the New Whim (erected in 1859) was reduced to 1*s.* 3*d.* Lastly, in 1861, there was drawn from an average depth of 260 fms., a weight of work estimated at 43,200 tons, or 3,600 tons per month. The monthly cost of this was 180*l.*, not including the labour of filling and landing. If we estimate this latter item as high as 4¾*d.* per ton, the cost per ton of the drawing will not reach 1*s.* 5*d.*

II. United Mines.—During 1855, there was drawn by one vertical and guided shaft, and from an average depth of 240 fms., a quantity of copper ore and "deads" estimated at 19,200 tons, or 1,600 tons per month. The consumption and cost were :—

| *In the Shaft.* | £ | *At the Engine.* | £ |
|---|---|---|---|
| Flat tarred hemp rope .. .. | 434 | Coal, 420 tons @ 16*s.* .. .. | 336 |
| Skips, maintenance and repairs .. | 50 | Grease, oil, &c. .. .. .. | 96 |
| Repair of guides .. .. .. | 144 | Engine-men, 3 men @ 3*l.* a-month | 108 |
| | 628 | | 540 |

| | £ | | £ |
|---|---|---|---|
| Filling .. .. | 216 | Total *Filling and Landing* .. | 336 |
| Landing .. .. | 120 | | |

The total cost was therefore 1,504*l.*, or 1*s.* 7*d.* *per ton* for drawing from a depth of 240 fms. Distributing these details of cost at per ton raised 240 fms., and 100 fms., and finding their percentage to the total, we have :—

| UNITED MINES. Nature of Cost. | Cost per Ton per— 240 Fathoms. Details. | 240 Fathoms. Partial Totals. | 100 Fathoms. Details. | 100 Fathoms. Partial Totals. | Percentage of Total. Details. | Percentage of Total. Partial Totals. |
|---|---|---|---|---|---|---|
| | *d.* | *d.* | *d.* | *d.* | | |
| In Shaft :— | | | | | | |
| Flat rope .. .. | 5·43 | 7·85 | 2·26 | 3·27 | 28·4 | 41·4 |
| Skips .. .. | ·63 | | ·26 | | 3·3 | |
| Guidage repairs .. | 1·8 | | ·75 | | 9·7 | |
| At Engines :— | | | | | | |
| Coal .. .. | 4·2 | 6·75 | 1·75 | 2·81 | 22·6 | 36·2 |
| Grease, &c. .. | 1·2 | | ·5 | | 6·4 | |
| Engine-men .. | 1·35 | | ·56 | | 7·2 | |
| Filling .. .. | 2·7 | 4·2 | 1·13 | 1·76 | 22·4 | 22·4 |
| Landing .. .. | 1·5 | | ·63 | | | |
| Totals .. | 18·8 | 18·8 | 7·84 | 7·84 | 100·0 | 100·0 |

The consumption of flat-rope is very heavy. In 1855 the United Mines purchased this article to the extent of 700*l.*, of which 423*l.* worth was set down as consumed in the shaft in question—which equals about 7 tons (at the rate of 60*l.* 10*s.* per ton), or about 550 fms., of 6″ rope consumed in

a year. If we take the cost of this rope at the more recent rate of 40*l.* per ton, or two-thirds of the above rate, the cost will be reduced as follows :—

| | Per Year. | Per Ton drawn. |
|---|---|---|
| | £ | *d.* |
| Rope consumed .. .. .. .. | 282 | 3·62 |
| Total cost.. .. .. .. .. | 1,352 | 17·0 |

It appears, therefore, that at the rate of 40*l.* per ton, rope is almost as economical as chain, notwithstanding the injurious atmospheric conditions of these mines. Indeed, Captain Tonkin has recently stated that the cost latterly at the United Mines has been 1*s.* 5*d.*, which would be about accounted for, supposing the other items fixed, by the reduction in the price of hemp as above shown. It would appear from this that there has been scarcely any improvement in this mine since 1855, while at Dolcoath, notwithstanding the multiplication of shafts, by improving the old system of drawing by kibbles, they are in a position to compete with them advantageously in an economical point of view. The tables given above render it easy to compare the systems at the two mines, so I need here merely refer to the remarkable identity between the percentage of the cost as classed under the three leading heads of—At the shaft—At the engine—and Filling and landing ; and to the greater economy in coal at the United Mines, from the use of flat-ropes.

III. Levant Mine.—At the period of my visit, in 1858, the fact of the failure of round wire-ropes had been ascertained, and the use of flat hemp ropes has been since resumed. I had, with the assistance of the agents, got out a certain amount of the figures bearing on the drawing at this mine, but as Mr. Hocking, the engineer, has more recently (in 1862) given very full numerical details on it, I have thought it preferable to adopt his information, adding to it a part of that which I had myself collected.

The examples of the two mines already given refer to a continuous drawing ; but Levant, notwithstanding the importance of its working, does not afford constant work for its guided shaft. Before the present shaft went to work, three whims, working with kibbles and chains, were considered insufficient ; while at present—except at Boscreggan shaft, where the man-engine winds now and then from a small depth—all the stuff broken in the mine is brought to the principal shaft to be drawn. The depth of this from surface was 240 fms. in 1858, and 245 in 1862. The drawing was from the following levels—the 130, 150, 170, 190 and 210 fms. under adit (which was 30 fms.). The 150 and 170 fms. levels were the most productive ; so that taking their mean depth, 160 fms., and adding that of the adit, 30 fms., we have 160 + 30 = 190 fms. for the mean depth.

The enlargement, cutting down, new timbering, and putting in guides in this 240 fms. of shaft cost about 2,000*l.*, or 8*l.* 6*s.* 8*d.* per running fathom ; and notwithstanding this heavy outlay, there are still three elbows, or changes of inclination, in the shaft. If required, it would be possible to draw 24,000 tons per annum through this shaft: in 1861, only 1,400 tons per month, or 16,800 tons per annum were drawn. All the expenses for one year being taken, the consumption and cost were :—

| *In the Shaft.* | | | £ | *s.* |
|---|---|---|---|---|
| Flat hemp ropes .. .. | | | 70 | 0 |
| Skips, a pair .. | £14 | 8*s.* | 32 | 8 |
| Skip wheels, 36 .. | 18 | 0 | | |
| Repair of shaft .. | 120 | 0 | 133 | 12 |
| Sheaves at elbows.. | 5 | 0 | | |
| Sundries .. .. | 8 | 12 | | |
| | | | 236 | 0 |

| *At the Engine.* | £ |
|---|---|
| Coal, 360 tons .. .. .. | 324 |
| Grease, oil, hemp .. .. .. | 24 |
| Engine-men, 2 men @ 3*l.* 5*s.* .. | 78 |
| | 426 |
| *Filling*, 4 men .. .. .. | 162 |
| *Landing*, 2 landers, 2 trammers .. | 138 |
| | 300 |

The total cost was therefore 962*l.* for the 16,800 tons, showing a cost of from 1*s.* 1½*d.* to 1*s.* 2*d.* *per ton* for drawing from a depth of 190 fms. Distributing this as in the cases of Dolcoath and United Mines, we have :—

| LEVANT. Nature of Cost. | Cost per Ton per— 190 Fathoms. Details. | Partial Totals. | 100 Fathoms. Details. | Partial Totals. | Percentage of Total. Details. | Partial Totals. |
|---|---|---|---|---|---|---|
| | *d.* | *d.* | *d.* | *d.* | | |
| At Shaft :— | | | | | | |
| Flat rope .. .. | 1·0 | 3·37 | ·53 | 1·77 | 7·3 | 24·5 |
| Skips .. .. | ·46 | | ·24 | | 3·4 | |
| Repairs .. .. | 1·91 | | 1·00 | | 13·8 | |
| At Engine :— | | | | | | |
| Coal .. .. | 4·63 | 6·08 | 2·43 | 3·21 | 33·7 | 44·3 |
| Grease, &c. .. | ·34 | | ·18 | | 2·5 | |
| Engine-men .. | 1·11 | | ·59 | | 8·1 | |
| Filling .. .. | 2·31 | 4·28 | 1·22 | 2·25 | 16·9 | 31·2 |
| Landing .. .. | 1·97 | | 1·04 | | 14·3 | |
| Totals .. | 13·73 | 13·73 | 7·23 | 7·23 | 100·0 | 100·0 |

Mr. Hocking very justly remarks that the wages of the two trammers should not properly be included in the cost of landing ; and that, besides, no reduction is made for the sale of old materials, and that the engine, being of insufficient power, consumes more coal than it properly should. But, referring to the information I myself collected on the spot, I think that these are balanced by certain other unfavourable items, and that the cost of winding at Levant is certainly not less than 1*s.* 2*d.* per ton.

Mr. Hocking also points out that with a continuous working, 2,000 tons per month might be drawn, at an increase in the cost of from 80*l.* 3*s.* 4*d.* to 90*l.* only, which would reduce the cost to 10¼*d.* per ton. We have here an example of the great inconvenience of a discontinuous system of drawing—resulting from the means being greater than required.

In 1858, with wire-ropes and large 14′ drums, the winding only continued for six hours out of the twenty-four, and 900 tons per month were drawn by overdriving the engine to such an extent as to cause a consumption of 24 tons 4 cwts. of coal in one month (July, 1858). If we reduce the amounts put down for the wages of the fillers and landers from 25*l.* to 20*l.*, as a compensation for their having some time to attend to other work, the cost per month under these conditions would be increased to 85*l.* 1*s.* 0½*d.* thus distributed :—

*In the Shaft.*

| | £ *s.* *d.* |
|---|---|
| Wire rope .. .. .. | 8 0 0 |
| Skips .. .. / Maintenance of guidage, &c. | 13 16 8¼ |
| Total .. .. | 21 16 8¼ |

*At the Engine.*

| | Tons. cwts. *s.* *d.* | £ | *s.* | *d.* |
|---|---|---|---|---|
| Coal, 45 4 @ 16 10 .. | | 37 | 19 | 4 |
| Grease, &c. .. .. .. | | 2 | 0 | 0 |
| One engine-man .. .. | | 3 | 5 | 0 |
| Total .. .. | | 43 | 4 | 4 |

*Filling and Landing* .. £ 20 *Total expense per month* .. £ 85 *s.* 1 *d.* 0¼

This, on the monthly turn out of 900 tons, shows a cost of 1*s.* 10¼*d.* per so that, by substituting flat hemp-rope for round wire-rope, and a

continuous working for an intermittent one, occupying only one-third of the day, the cost per ton of drawing at Levant has been *reduced by one-half.*

IV. CARN BREA MINES.—The Carn Brea mines, near Redruth, after having, like Dolcoath, been very rich for copper, are in their turn becoming productive for tin. The workings include several lodes, and an extent of about 1,000 fms. from east to west, by a width of 500 fms., comprising in reality six distinct mines. The following were their names and maximum depth in 1860:—

1. Tregajorran, on Teague's lode, 197 fms. under adit.
2. Highburrow, to the north of the above, on the same lode as the adjoining mine of Tincroft, 165 fms.
3. The western part of Teague's lode, 145 fms.
4. Wheal Fanny, on the lode of that name, 125 fms.
5. Wheal Druid, much further south, 166 fms.
6. Barncoose, in the north-east part of the sett, an entirely distinct mine, and for many years a prosperous one, 116 fms. under the adit, which is 30 fms. deep.

Barncoose has been one of the principal sources of the tin returned by Carn Brea mines, and skips and flat-ropes have been adopted here. In 1858, the drawing was principally from the 80 and 90, or from an average depth of 115 fms.

Captain Daw, the manager of Carn Brea, takes a very accurate annual account of the cost of drawing and dressing, and, what is more, communicates them in a most obliging manner. In 1857, there were six engines* employed in winding; two working constantly—three working sixteen hours out of the twenty-four—and one twelve hours only. They are connected with a dozen shafts, but unfortunately there is no longer any account kept of the important item of the maintenance and repair of the latter.

There were drawn monthly 2,000 tons of tin-stone, and 1,000 tons of copper ore and deads, or 36,000 tons per annum, from an average depth of 150 fms. The consumption and cost were:—

| *In the Shaft.* | £ | *At the Six Engines.* | £ | s. | d. |
|---|---|---|---|---|---|
| Chain and flat ropes .. .. } Kibbles and skips .. .. } | 640 | Coal, 990 tons .. } Tallow, oil, &c. .. } | 841 | 0 | 11 |
| Maintenance and repairs .. | — | Engine-men .. .. | 272 | 0 | 10 |
| | | Total .. | 1,113 | 1 | 9 |

| | £ | s. |
|---|---|---|
| *Filling and Landing* .. .. .. .. | 962 | 10 |

The total cost was therefore 2,715*l.* 11*s.* 9*d.*, or 1*s.* 6¼*d.* *per ton* for drawing from a depth of 150 fms. Distributing as before, we have:—

| CARN BREA. 1857. Nature of Cost. | Cost per Ton per— 150 Fathoms. | 100 Fathoms. | Percentage of Total. |
|---|---|---|---|
| | d. | d. | |
| In Shaft .. .. .. .. | 4·26 | 2·84 | 23·5 |
| At six Engines .. .. .. | 7·42 | 4·94 | 41·0 |
| Filling and Landing .. .. .. | 6·42 | 4·28 | 35·5 |
| Totals .. .. .. | 18·10 | 12.06 | 100·0 |

* The particulars of these will be given further on.

Captain Daw has since communicated the results for 1860 to Mr. H. C. Salmon, from whom I borrow them. By doing away with the Old Sump Whim, five engines only were working. Their detailed consumption is given for the first nine months of the year, as well as the wages of the fillers and landers; while the materials used in the shaft are given for the entire year. This information I have tabulated in the following table. The quantity drawn per month in 1860 was stated at—

| | |
|---|---|
| Tin-stone .. .. .. .. .. | 3,000 tons. |
| Copper ore and deads .. .. .. .. | 1,000 „ |
| Total .. .. .. | 4,000 „ |

but I think we may reduce the estimate to 46,000 tons for the year. The average depth was not stated; but, notwithstanding the extension of the deeper workings, it did not probably exceed that of 1857, since Barncoose, only drawing from 120 fms., alone yielded half the tin. I shall consequently take the average depth at 150 fms.

The cost *per ton* was therefore 1*s.* 2½*d.* for drawing from a depth of 150 fms. I am unable to supply with any exactness the want of particulars as to the cost of maintaining the shaft, but I do not think that it exceeds 5*d.* per ton in this instance. Compared with the mines which we have already referred to, the cost would therefore be from 1*s.* 7½*d.* to 1*s.* 8*d.*—that is, notably higher—a result evidently due to the multitude of shafts, and the intermission of the working. Still the year 1860 shows a sensible economy on 1857—which is no doubt due to one engine being dispensed with—to a greater concentration of the workings and their more vigorous development, which has made the drawing more active—and lastly to the increased production of Barncoose where skips and flat-ropes are used.

V. South Frances Mine, October, 1861.—It may not be without interest to add to the preceding examples that of South Frances, as given by Mr. Twite; remembering however that the account only comprises a month—which is certainly too short a period—and that the load of the skip is averaged at 17 cwts., which may be presumed to be too high. The shafts are worked in conjunction, but Pascoe's shaft is more productive than Marriott's.*

In October, 1861, about 1,100 tons were drawn, as follows:—

| | | | Tons cwts. |
|---|---|---|---|
| From Marriott's.. | .. 572 | skips of ore @ 17 cwt. each .. .. | 1,068 9 |
| „ Pascoe's .. | 685 | (skips of ore, as above) | |
| | 267 | skips of 4 miners, each man weighing on an average 140 lbs. .. | 66.15 |
| | | | 1,135 4 |

The working was discontinuous, from an average depth of 126 fms.; and the consumption and cost were:—

| *In the Shaft.* | £ | *At the Engine.* | £ s. |
|---|---|---|---|
| Round wire-rope, 3½" .. | 3 | Coal, 10 tons 18 cwts. @ 15*s.* 6*d.* | 8 9 |
| Skips .. .. .. .. | | Oil, grease, hemp .. .. | 1 10 |
| Maintenance .. .. .. .. | – | Engine-men, 2 men .. .. | 7 10 |
| | | Total .. .. | 17 9 |

* The particulars as to the conditions of the shafts, the size of the ropes, sheaves and cages, are given in the First Part, §8.

## CARN BREA, 1860.

| Details of Cost for Drawing 46,000 tons from an average Depth of 150 fms. | | | | | | | | Cost per Ton per— 150 Fathoms. Details. | 150 Fathoms. Partial Totals | 100 Fathoms. Details. | 100 Fathoms. Partial Totals. | Percentage of Total. Details. | Percentage of Total. Partial Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tons. | cwts. | qrs. | lbs. | £ s. | £ | d. | d. | d. | d. | | |
| In Shaft .. | Flat rope .. .. | 2 | 0 | 0 | 0 | @ 40 0 | 80 | 2·62 | | 1·75 | | 18 | |
| | Chain .. .. .. | 16 | 3 | 3 | 26 | „ 26 0 | 422 | | 3·38 | | 2·25 | | 24 |
| | Kibble-plates .. .. | 2 | 0 | 0 | 0 | „ 15 0 | 30 | | | | | | |
| | Waggon-plates, for skips | 2 | 0 | 0 | 0 | „ 17 10 | 35 | ·76 | | ·50 | | 6 | |
| | Cost of making and castings .. | | | | | | 55 | | | | | | |
| | Sundries .. | | | | | | 25 | | | | | | |
| | Maintenance | | | | | | — | — | — | — | — | — | — |
| | | Tons. | cwts. | qrs. | lbs. | s. d. | £ s. d. | | | | | | |
| At Engines | Coal .. | 962 | 14 | 0 | 0 | @ 16 6 | 794 5 0 | 4·14 | | 2·76 | | 29 | |
| | Hemp, &c. | 0 | 6 | 0 | 16 | „ 0 5 | 14 11 8 | | | | | | |
| | Tallow .. | 0 | 12 | 1 | 4 | „ 60 0 | 86 17 1 | ·40 | 5·95 | ·27 | 3·97 | 8 | 42 |
| | Oil.. .. | 440 pints | | | | „ 0 6½ | 11 18 3 | | | | | | |
| | Candles .. | 464 lbs. | | | | „ 0 6½ | 12 11 4 | | | | | | |
| | Engine-men .. | | | | | | 271 0 0 | 1·41 | | ·94 | | 10 | |
| | Filling .. | | | | | | 487 13 4 | 2.54 | 4·95 | 3·30 | 3·30 | 34 | 34 |
| | Landing .. | | | | | | 462 0 0 | 2·41 | | | | | |
| | Totals .. .. | | | | | | 2,737 16 8 | 14·28 | 14·28 | 9·52 | 9·52 | 100 | 100 |

The total cost was therefore 36*l.* 9*s.*, or about 8*d.* *per ton* for drawing from a depth of 126 fms. This is on the assumption that 1,100 tons were drawn; but in distributing the cost in the following table, I have only taken the quantity drawn at 1,000 tons.

| SOUTH FRANCES. Nature of Cost. | Cost per Ton per— | | Percentage of Total. |
|---|---|---|---|
| | 126 Fathoms. | 100 Fathoms. | |
| | *d.* | *d.* | |
| In Shaft (not including maintenance) | ·72 | ·57 | 8 |
| At Engine { Coal .. .. / Grease.. .. / Engine-men .. } | 4·19 | 3·32 | 48 |
| Filling and Landing .. .. .. | 3·84 | 3·04 | 44 |
| Totals .. .. .. | 8·75 | 6·93 | 100 |

(*To be continued.*)

## CORNWALL AND DEVON MINING DIRECTORY.

*The Cornwall and Devon Mining Directory: Classified in Districts.* Compiled by J. Williams. Second Edition. London: W. Kent and Co.; Truro: Heard and Sons; Hayle: Banfield Bros.

The object of this little book is a most useful one, and as far as we have seen, by looking cursorily through it, the idea has been faithfully carried out. The arrangement of the mines in districts is an excellent one, and is a great improvement on a similar form of Guide published some years ago by the *Mining Journal* Office. There is still much imformation that might be advantageously added to make the Directory generally useful; but if it becomes an annual publication, as the compiler seems to anticipate, no doubt additional information will be continually incorporated.

*Revista Minera, Periodico Cientifico é Industrial,* redactado por una Sociadad de Ingenieros. Tomo xiii, 1862; 6 tomo xiv, núm. 303-313, 1863. Madrid: Plazuela de la Cebada, núm. 13.

This Spanish periodical, although primarily devoted to mining and metallurgy, includes like the *Annales des Mines* a large amount of general engineering matter, particularly such as relates to railways. It is published at Madrid on the 1st and 15th of each month, each number containing two 8vo. sheets, with occasional plates, and is at present edited by the following committee—some of which are well-known names:—*Director:* Don Casiano de Prado; *Secretary:* Don Jose de Monasterio; *Editors:* Don Lucas Aldana, Don Manuel Abeleira, Don Lino Peñuelas, Don Juan Pablo Lasala; *Registrar:* Don Luis Barinaga. The numbers that have appeared this year contain the following papers:—

Sobre la adopcion de voces nuevas en la geologia.
Cotos mineros.
Rápida ojeada sobre las minas de Rio-tinto.
Sobre la geologia de Santo Domingo.
Mapa agronómico de las cercanias de Paris.
Sobre las Minas de Lepanto.
Sobre las Minas de la Sierra de Tharsis.

Influencia de los ferro-carriles en la higiene pública.
Abastecimiento de aguas en Toledo.
Riqueza minera de Francia.
Sobre los depósitos carboniferos de Utrillas y Gargallo.
Nuevo sistema de enganche para los wagones de los ferro-carriles.
Descripcion del terreno numulitico de Mallorca.
Descubrimiento del orígen del Nile.
Carbones minerales.
Isla de Santo Domingo.

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## ON THE LIBERATION AND DRAINAGE OF GASES FROM COAL MINES.

At the last meeting of the Manchester Geological Society, Mr. Joseph Goodwin, of the Hyde and Haughton Collieries, read a paper on this subject, in which he stated that the gases met with in coal mines are carbonic acid and light carburetted hydrogen, better known by the names of black (or choke-) damp, and fire-damp. Occasionally carbonic oxide, sulphuretted hydrogen, and other gases are met with. The precise circumstances under which carburetted hydrogen has been formed are a matter of conjecture, but it is probably derived from the decomposition of vegetable matter in the coal seams. The causes producing the other gases are numerous: the decomposition of coal *in situ*, of iron pyrites, and of other minerals, and the rapid decay of timber and other substances. There are also the gases formed by the breathing of men and animals, the combustion of lights, and the blasting of coal by powder. Carburetted hydrogen sometimes proceeds more freely from the roof of the mine than the floor, and *vice versâ*, but in either case it is also given off from the coal seam. Carbonic acid gas does not appear to be given off from the coal, neither have the remaining gases been yet proved to emanate from the coal.

The circumstances under which gases are liberated or drained from coal seams vary considerably. It would be in vain to lay down a rule as to the distance a coal seam can be drained of gases by working out an upper or under seam. It seems possible that gases may be liberated, or drained, from coal *in situ* by working an under seam, the falls of roof in which reach up to an upper seam; or by working out an upper seam, separated by only a few feet of strata from an under one, in which carburetted hydrogen exists under great pressure, or that in opening out a maiden field, the exploring drifts may drain the drifts that follow them. But it does not seem possible for a mine to be drained of carburetted hydrogen by working another seam at a distance of thirty yards or so. Mr. Goodwin cites some cases where coal seams have been worked at distances varying from 4 ft. to 14 yards and upwards, without producing any such effect. One of these occurred at Clayton Colliery on the 14th of April last. Some time previously a brow was driven in the Four-feet mine, on the one side of which was the engine-brow, at a distance of 26 ft., and on the other side the return air-course, at a distance of 10 ft.; besides which, levels had been driven at right-angles to the brows, at a distance of 12 yards from each other. In driving the brow, a considerable quantity of carburetted hydrogen was found to be given off from the coal almost the whole length of the brow; and on the morning previously named more than 30 cubic yards of space was filled with explosive gas in less than an hour. The engine-brow, return air-course, and levels have been driven more than ten years, and therefore, the gas had had time enough to have drained from the coal, if it would have drained at all.

In another case in the Peacock Mine, at the Hyde Colliery, two levels

had been driven for many years, and were being worked back towards the shaft, when the roof of one of the works fell, and rendered it necessary to cut up within a foot or 15 in. of the old working face, in order to regain it. In so doing a considerable quantity of gas was given off from the coal, although on the one side was a thrill, or cross-cut, at the distance of three yards; and on the other side, not more than 15 in. of coal to where a current of air was passing, the distance between the levels in this case was from 11 to 12 yards. Another instance occurred at the same colliery in driving a pair of brows in the Black Mine. After being driven 2 or 3 yards each, a drill hole was made in the top part of the coal for the purpose of inserting a plug. This drill hole was not more than 8 in. in depth, yet it liberated such a quantity of gas that it was with difficulty extinguished after it became ignited.

At Fairbottom Colliery, according to Mr. Horsfall, in the Black Mine, at the Broad Oak pit, there is a rank 120 yards long and 10 yards in breadth. At certain distances are cut-throughs, when driving which the greatest difficulty is experienced from the time 2 or 3 ft. are cut down, in consequence of the gas given off the coal. The pillars above the rank referred to have been worked out a considerable number of years, so that the gas had had sufficient opportunity of being drained, if such had been possible. At the same pit, in driving through a pillar of coal only 5 ft. in width, a considerable quantity of gas was given off from the coal. At the Heys Colliery, two mines have been worked 14 yards apart; in the bottom seam they have been working back the coal for some time, and in the upper one narrow work is being driven previous to removing the pillars; yet the upper mine gives off great quantities of carburetted hydrogen. These are not the only cases that could be cited to show that the distance that gases will drain from coal seams is very limited.

Referring to the law of the diffusion of gases, Mr. Goodwin stated that in the mine we invariably find the carbonic gas to occupy the lowest position, and the carburetted hydrogen the higher. He instanced a case of the former gas occupying the lower side of a waggon road for upwards of 50 yards, so that a light was extinguished by putting it into the gas as suddenly as by immersing it in water, while on the higher side a light would burn readily. On the other hand he instanced a case where he had crawled for nearly one hundred yards along a level where the gases would explode on the higher side, while the presence of carburetted hydrogen could not be discovered by the safety lamp on the lower side. It is a fact beyond doubt that carburetted hydrogen occupies the highest stratum in the atmosphere of a mine, and carbonic acid the lowest. It has been suggested that this departure from the general law of the diffusion of gases may be caused by the gases being given off more quickly than the law of diffusion acts; but Mr. Goodwin does not consider this suggestion a sufficient explanation, for he has seen places where the same conditions have been held good after being undisturbed for months.

As it is well known that the admixture of a certain proportion of atmospheric air with carburetted hydrogen is necessary to make the latter explosive; and as this explosive compound would, from such admixture of atmospheric air, be heavier than the pure carburetted hydrogen, it would appear from these facts that we should expect the highest stratum in the atmosphere of a mine to be less explosive than the stratum beneath. This however is not the case, for fire-damp is met with in many places where at the floor its presence cannot be detected in the lamp, but by raising the lamp a little the flame becomes elongated, and as the lamp is raised the flame gradually increases, until at the roof of the mine it will explode and fill the lamp.

# Correspondence.

## NATIVE SULPHUR IN CORFU.

SIR,—The occurrence of sulphur in a native state in the island of Corfu has recently been alluded to in some of the public papers. The following are some particulars which may interest your readers.

In the north western part of the island, near the village of Spagus, there is an extensive district occupied entirely with gypseous rocks, consisting partly of gypseous marls and partly of gypsum bands. There are also calcareous marls less gypseous. It should be understood that this is not a condition peculiar to this district, as I have noticed the same thing elsewhere in Corfu and also in Cephalonia, Zante, and Santa Maura.

It is amongst these gypseous marls and bands of gypsum that the sulphur appears. It is in bands consisting of pure semi-crystalline native sulphur, arranged (much in the same manner that the mineral *Wavellite* is found in hard argillaceous shales) between the bands of hard gypsum. Many of these hard bands give out a strong sulphurous odour when struck. The number of bands is not very clearly made out, and is probably irregular, but as they are from half-an-inch to one inch thick, and in one group near the surface there are certainly ten or a dozen, while a lower group is described as even richer, it would seem that the quantity of sulphur is large. The extraction would also be easy, as there is no overlying load of earth, and the upper series of sulphur bands are contained within a thickness of ten feet of gypsum.

Springs of pure water, and other springs of water strongly charged with sulphuretted hydrogen, occur in the neighbourhood.

The exact limits of the deposit are not made out.

I am, &c.,
D. T. ANSTED.

Impington Hall,
Cambridge, 20*th July*, 1863.

# Notes and Memoranda.

A NEW ALUMINIUM ORE.—At the last meeting of the Lower Rhenish Natural and Physical Society (*Niederrheinischen Gesellschaft für Natur- und Heilkunde*) at Bonn, Dr. Wedding exhibited a specimen of an ore of aluminium which had lately been recognised as such by Deville, but had formerly been smelted as an iron ore. It has been applied by MM. Morin and Co. of Nanterre, and Messrs. Bell of Newcastle to the manufacture of aluminium. From the place of its discovery, Beaux, near Avignon, it has been named Beauxite; and according to Meissonier it penetrates the chalk beds as a vein-like mass for a length of nearly two miles. It consists essentially of alumina, peroxide of iron (which reciprocally replace each

other), and water, and contains very small quantities of silicic acid, titanium, and vanadium. Some varieties contain about 80 per cent. of alumina, and others almost as much oxide of iron.

MANCHESTER GEOLOGICAL SOCIETY.—The monthly meeting of members was held on Tuesday, June 30th, Mr. J. Dickinson, F.G.S., in the chair. A paper was read by Mr. J. Plant on "The Effects produced on Rowley Rag by Heat," and one by Mr. Joseph Goodwin on "The Liberation and Drainage of Gases from Coal Mines."

METAMORPHISM OF DOLOMITE INTO POTSTONE.—Dr. A. Gurlt read an interesting communication at a recent meeting of the Lower Rhenish Natural and Physical Society on the metamorphism of dolomite (*i.e.*, a double carbonate of lime and magnesia) into potstone, a mineral of the talc family (*i.e.*, a hydrated silicate of magnesia). This is observed on a very large scale at the Raasdals-Fjeld, to the south-west of the Laugaard post-station in Gudbrands-dalen in the centre of Norway, between the confluence of the Lougen and Otta-Elv. A large dolomite deposit, which is considered as Devonian, is found overlying the so-called Jätta-Quartzite for an extent of more than ten geographical miles, from Elstad to the foot of the Dovrefjeld. The petrographical and chemical nature of this dolomite is very varying; it is found compact, cellular, or crystalline in structure, and its contents of carbonate of magnesia range from less than 10 to more than 40 per cent. On the south-west side of the Raasdals-Fjeld this dolomite is found in connection with veins of an amphibolitic trap, and has here completely lost its original character, being found to be changed into potstone. This mineral, which belongs to the talc family, and is found in the Fichtelgebirge, in the Central-Alps, and in other localities, is obtained here in large masses, and is made into pots, kettles, oven-plates, &c. It contains isolated crystals of dolomite (bitterspar rhombohedrons) and sometimes contains so much carbonic acid that it effervesces with acids. The gradual change of the dolomite into the potstone is completely established, and it is beyond doubt that the latter is a metamorph of the former. Dr. Kjerulf, of Christiana, believes that this change may be directly ascribed to the amphibolitic trap mentioned. But as this nowhere occurs in any considerable quantity, and as, besides, neither it nor the dolomite contains water, although the metamorphic product is rich in water, the metamorphosing influence cannot well be a direct one. But it is very probable, from the unmistakeable connection between the potstone and the amphibolite, that in the vein-fissures opened by the latter, there may have risen up hot springs holding silicic and carbonic acids in solution; which may have caused the carbonate of lime of the dolomite to be dissolved and carried away, and the remaining carbonic acid to be removed by the silicic acid—this silicic acid with the water settling in the rock and giving rise to the formation of potstone.

NORTHERN INSTITUTE OF MINING ENGINEERS.—At the monthly meeting of this society, held on Thursday, June 5th, Nicholas Wood, Esq., President, in the chair, the continuation of a paper by Messrs. Atkinson and Dalglish, on "Paradoxes in Ventilation of Mines," was read.

MAGNESIUM AS A COMMERCIAL PRODUCT.—Mr. E. Sonstadt has patented a process for the production of magnesium upon a commercial scale. Several objections have, however, been urged, both against the patent right and the practicability of the process. In the first place, it is doubtful if Mr. Sonstadt's patent will not at all events be materially interfered with by the fact, that an analogous process was described by Deville before this patent was secured. Secondly, there is no prospect of the metal ever being produced at a lower price than aluminium is at present, that is about 4*s.* an oz., or 20 per cent. less than silver; and for some time to come the cost will most probably be 10*s.* an oz., or double the price of silver. Thirdly,

on exposure to the air a film of magnesia is formed upon it, which, unlike the case of silver, cannot be cleaned off by friction, but requires benzine or some similar substance. Lastly, it requires to be worked at a high temperature, and will inflame on the slightest excess.

Purified Coke for Iron Smelting.—Mr. E. Kopp describes a new mode of purifying coke. After conversion of the coal into coke in the usual way, on its being taken red-hot from the furnace, it is generally extinguished by throwing a large quantity of water over it. Mr. Kopp proposes to acidulate this water with hydrochloric acid. The incandescent coke is probably contaminated by protosulphide of iron (proceeding from the pyrites), sulphide of calcium (proceeding from the reduction of sulphate of lime), with phosphates, silicates, &c. By contact with the diluted hydrochloric acid, the sulphides of iron and calcium are transformed into chlorides of iron and calcium, with disengagement of sulphuretted hydrogen, which is at once carried away. The phosphates are converted into soluble biphosphates, and even the silicates may have their bases dissolved as chlorides, a portion of the silica at the same time becoming soluble. Were the coke now allowed to dry immediately, these chlorides, biphosphates, and silica would of course remain; but the sulphuretted hydrogen, and with it nearly all the sulphur, would have been eliminated. But, if it be now washed with water, a large portion of these impurities are entirely expelled, and the resulting coke is almost quite pure. To impart to this coke still more the qualities of charcoal, it may be sprinkled with a weak solution, or powdered over with dry carbonate of soda, as free as possible from sulphate. The carbonate of soda prepared from cryolite answers best for this purpose. In most instances finely-powdered cryolite may, with advantage, be added to the coke, to the extent of $\frac{1}{3}$ to $\frac{1}{2}$ per cent.

Association for the Prevention of Steam-Boiler Explosions.—The monthly meeting of the executive committee of this association was held at Manchester, on Tuesday, June 30th, when Mr. L. E. Fletcher, chief engineer, read his report. From this it appears, that during the month of June nine explosions occurred, by which eleven persons were killed and twenty-one injured. In the case of one explosion, at an ironworks, the boiler was fifteen years old, the plates over the furnace had already been repaired, and it was stated that the seams at that part had been observed to be leaking only a quarter of an hour before the explosion took place. In the case of an explosion which occurred to another boiler—an upright furnace one, working in connection with two others of similar construction heated by flames which passed through an internal tube, running down directly from top to bottom through the centre of the boiler—it was found that the explosion resulted from the collapse of this tube; but it was impossible to say whether it had got out of shape or not, as the boiler had been in such constant work that no opportunity had been afforded for the association to examine it thoroughly for upwards of three years.—Mr. Fletcher concluded by calling attention to the importance generally of having spare boilers, so that a suitable opportunity may be afforded for examination, as well as for cleaning and repair.

Royal School of Mines.—At a meeting of the Council, on Saturday, July 4, his Royal Highness the Duke of Cornwall's Scholarship was awarded to Mr. F. G. Finch. The two first years' Royal Scholarships were awarded to Mr. T. Gibb and Mr. E. O'Sullivan. The second year's Royal Scholarship was awarded to Mr. T. Gibb. The Edward Forbes medal and prize of books, together with the De la Beche medal and prize of books, were awarded to Mr. E. B. Tawney. The directors' prize of 25*l.* was awarded to Mr. F. G. Finch.

Coating of Metallic and Vegetable Substances.—Mr. Duncan has specified an invention for an improved compound for coating metallic and vegetable substances, to preserve them from corrosion or decay. The compound is prepared from marine glue, gutta percha, India rubber, shellac, or other analogous substances, vegetable or mineral pitch, iodine, sulphur, creosote, combined with alumina, quartz, marble, sand, chalk, glass, emery, white oxide of zinc or of lead, or litharge, in every case reduced to a fine powder, in proportions varying from one-fourth part to five parts of these powdered materials to one part or more of the plastic substances. Immediately after the coating has been laid on (which is done hot), it is to be covered with a layer of one or more of the mineral powders before mentioned, in a warm state, in order entirely to remove all stickiness, and when it has become cool, the surface may be brought to a smooth or polished exterior. In cases where it is necessary, the metals or woods may receive a further protecting coating or varnish, which may be repeated if it is desired to obtain extra thickness and protection. The mineral earthy substances must in all cases be thoroughly washed and freed from impurities, and then be kiln-dried, to desiccate and destroy vegetation. The compound may be applied to hemp ropes and similar materials.

London Association of Foremen Engineers.—The ordinary monthly meeting of this society was held on July 4th, when Mr. Muir read a paper on "Heavy Forgings in Iron," on which a long and practical discussion followed.

Miners' Lamps.—Provisional protection has been granted to Mr. Bourne, of Cumberland, colliery viewer, for "improvements in miners' lamps." These consist of means for extinguishing the light of the lamp by the act of opening it, and before the gauze covering can be removed. For this purpose there is attached to the lamp a lever apparatus, mounted on a suitable fulcrum, and which is depressed on the wick by the act of removing the wire gauze covering. This is, by the action of a suitable spring, or by the weight of the short end of the lever, kept out of the way of the ignited wick so long as the gauze covering remains on the lamp, but as soon as any attempt is made to remove this, a small projecting piece attached to its mounting is forced under the short arm of the lever, which is thereby elevated, and the other end of the lever depressed on the wick, by which means the light is extinguished.

Electrolytic Action in Armstrong Shot.—In the last number of the *Journal of the Chemical Society*, Mr. F. A. Abel, F.R.S., points out some curious and unexpected instances of voltaic action in certain lead-coated Armstrong projectiles. The coating (which is an alloy of lead, with a small proportion of tin or antimony) is attached to the body by two methods:—mechanically, by grooving the body, or chemically, by covering it with a film of zinc (by the so-called galvanising process) before putting on the coating of soft metal. In the latter method, the lead-alloy becomes perfectly attached to the body of the projectile by the medium of the zinc. When the coating has been attached mechanically, it has been frequently found to become distorted by considerable changes of temperature; but when it has been attached by means of the zinc, a very different set of effects are sometimes observed. On various parts of the shells, the soft metal is found to become raised in the form of blisters from $\frac{1}{4}''$ to $1''$ in diameter—the only inference derivable from whose appearance is that they had been produced by the generation of gas between the iron and the soft-metal coating. On examination this has been ascertained to be the case;

for on being punctured under water a quantity of pure hydrogen gas was found to escape, which had existed under the coating subject to a pressure of ten atmospheres. From these facts it was evident that the blisters had been produced by the gradual disengagement of hydrogen between the body of the projectile and the coating; a result that must have been due to the electrolytic decomposition of some hydrogen-compound, which had become enclosed between the metals. Further examination showed this to be portions of water that had become accidentally absorbed by the small proportion of chloride of zinc formed in the galvanising process—the tendency of the chloride of zinc to absorb and retain water at high temperature being well known. Mr. Abel adds, however, that these distortions are not of frequent occurrence, and do not interfere with the efficiency of the projectiles.

VANADIUM OCHRE, AND OTHER SOURCES OF VANADIC ACID.—Dr. T. L. Phipson has recently read a paper before the Chemical Society on this subject. After referring to M. Beauvallet's method of collecting the acid, and comparing it with a method of his own, he goes on to describe a substance that occurs in Saxony, which he calls Vanadium Ochre. This mineral, which is a sort of reddish brown bog iron-ore, composed essentially of round hard grains of limonite, held together by a ferruginous argillaceous cement, is found on analysis to contain 1·9 per cent. of vanadic acid; all of which, together with 2·2 per cent. of phosphoric acid occurs in the argillaceous cement that holds the grains together. As the ratio of these two acids in the mineral is exactly 2:3, Dr. Phipson considers that the compound of vanadium present is the phosphate $\dddot{\mathrm{V}}\mathrm{d}_2\,\dddot{\mathrm{P}}\mathrm{h}$ described by Berzelius. After referring to the various clays and other substances found to contain vanadic acid, he states that the preparation of the acid on a large scale, particularly from pitchblende and vanadium ochre, is by no means a complicated process, and can often be effected without converting the acid into a baryta-salt.

## Patents relating to Mining and Metallurgy.

### APPLICATIONS AND PROTECTIONS ALLOWED.

May 1st to July 24th, 1863.

924. T. Ramsbottom, "improvements in machinery for hammering, rolling, and shaping metals."

1,115. J. H. Johnson, from Adrien Muller, "improvements in the manufacture of iron and steel."

1,164. J. Norie, "improvements in making moulds for casting, and in apparatus therefor."

1,189. T. Warren, "improvements in glass and other furnaces or kilns."

1,209. R. A. Brooman, from H. A. T. de Beauregard, "improvements in the extraction of hydro-carburets from minerals, in the distillation thereof, and in apparatus employed therein."

1,238. E. B. Wilson, "improvements in the manufacture of iron and other metals, and in the apparatus employed therein, parts of which are applicable for other purposes where high temperatures are employed."

1,242. H. Bennett, "improved apparatus or mechanism to be used for facilitating the puddling of iron."

1,278. E. Sonstadt, "improvements in the manufacture and purification of the metal magnesium."

1,025. W. A. Shaw, "a mode of lining lead pipe with tin or its alloys."

1,049. W. E. Gedge, from J. B. Mousadie, "improvements in twyers or blast pipes, and in apparatus connected therewith."

3,053. F. Bennett, "an improved method of condensing lead and other metallic fumes and vapour from furnaces."

1,059. S. Ingledew, "certain improvements in the method of obtaining iron from its ore, and in subsequent treatment thereof for converting the product into a metallic state, and in apparatus connected therewith."

1,061. S. Crabtree, "improvements in balling motions."

1,063. A. Kinder, "improvements in the manufacture of sheet metal, and in ingots, or plates of metal, and in machinery or apparatus employed therein."

1,319. J. W. Burton, S. G. Rhodes, S. E. Slanor, "an improved machine or apparatus for getting coals or other minerals."

1,322. J. Munro and R. Scott, "improvements in apparatus for boring, mining, and excavating, or cutting; in motive power engines, and in pressure gauges."

1,331. H. C. Coulthard, "improvements in blast engines."

1,420. J. G. Jones and R. Ridley, "improvements in machinery and apparatus for working coal and other mines."

1,431. C. Niquet, "improvements in apparatus for sifting and washing ores."

1,433. R. H. Brooman, from J. Saunders, "improvements in the distillation of bituminous substances."

1,444. J. Brooke, "improvements in miners' lamps.

853. A. P. Price, "improvements in apparatus employed for fusion, manufacture, production, and refining of metals."

1,470. G. Bedson, "improvements in cupolas and blast furnaces."

1,513. W. H. Dawes, "improvements in the manufacture of iron."

1,541. W. E. Newton, from A. H. Hamon, "improvements in the manufacture of leaden pipes."

1,602. R. Mushet, "improvements in the manufacture of iron and steel."

1,612. J. Griffiths, "improvements in machinery for puddling iron and steel."

1,613. R. Mushet, "improvements in the manufacture of iron and steel."

1,632. J. H. Johnson, from X. F. Girard, "improvements in coating or covering metal sheets with metals or alloys, and in apparatus employed therein."

1,760. J. Davison, "improvements in furnaces for boilers, smelting, and other useful purposes."

1,728. W. Henderson, "improvements in treating ores and other substances containing iron, in the manufacture of iron, steel, and alloys of iron, and of a purifying and deoxidising agent therefrom, also in the construction of retorts or kilns for treating the said ore and substances."

1,763. E. Sonstadt, for "improvements in the manufacture of sodium."

### Notices to Proceed.

44. 1863. J. Leigh, "improvements in the treatment of gas produced by the distillation of coal, cannel, bituminous shale, boghead, mineral oils, petroleum, or other combustible substances, and for the obtaining of certain products therefrom."

42. 1863. C. T. Judkins, from M. G. Farmer, United States, "new alloys."

48. 1863. E. V. Gardner, "improvements in the treatment of petroleum and mineral oils, and in apparatus employed therein."

167. 1863. J. Mosheimer, "improvements in machinery for crushing and grinding quartz and other substances."

522. 1863. E. B. Wilson, "improvements in the manufacture of an alloy or alloys of titanium and iron."

956. 1863. Isham Baggs and W. Simpson, "improvements in purifying and treating coal gas, sulphuretted hydrogen, and other gases containing sulphuretted hydrogen, and in obtaining sulphur, sulphuric, and other acids in such treatment."

247. 1863. E. F. Prentiss and J. C. Sellars, "improvements in treating rock oil, petroleum, paraffine oil, coal oil, and paraffine and other like mineral oils and products therefrom."

1,322. 1863. J. Munro and R. Scott, "improvements in apparatus for boring, mining, and excavating or cutting in motive power engines, and in pressure gauges."

385. 1863. G. H. Birkbeck, from C. Rosung, "improvements in processes or means employed for separating or extracting silver or other metals from lead."

646. 1863. R. Mushet, "an improvement in the manufacture or treatment of pig or cast iron."

788. 1863. R. Mushet, "improvements in moulds to be used for casting steel and homogeneous iron."

903. 1863. G. Lowe, "improved machinery for boring rocks and other hard substances."

560. 1863. V. D. Delahaye, "improvements in apparatus for clearing and excavating pit coal and rock or earth."

679. 1863. J. Polkinghorne, "improvements in treating tin ores, and in apparatus for treating ores and matters containing arsenic."

708. W. E. Newton, from E. G. Borgues and P. Rambourg, "improvements in the manufacture of iron and steel."

1,602. 1863. R. Mushet, "improvements in the manufacture of iron and steel."

1,513. 1863. W. H. Dawes, "improvements in the manufacture of iron."

## Patents Sealed.

### May 1st to July 24th.

3,472. Johnson, "improvements in ingot moulds employed in casting of steel."—From H. U. Petin and J. M. Gaudet.—(30th Dec., 1862.)

3,159. A. L. Woolf, "a new and improved metallic alloy."

3,176. J. Halford, "improvements in the preparation and treatment of a mineral substance obtained from coal or slack, whereby a certain carbonaceous product is obtained and rendered available for use in the manufacture of iron, steel, in the processes of casting and moulding metals, and in the manufacture of paint and such like articles."

3,384. T. Clayton, "improvements in reverberatory furnaces for heating large masses of iron and steel, and in economising the waste heat of the said furnaces."

3,322. R. Clark, "improvements in machinery or apparatus for boring, winding, and lifting for mining purpose."

501. G. Davies, from J. F. Stileman, and Z. Ellis, "an improvement in melting and smelting furnaces."

3353. J. McInnes and E. F. Prentiss, "improvements in the distillation and treatment of petroleum and other like oils, to obtain products therefrom, and in the apparatus to be used therefor, parts of which can be applied to distilling other liquids."

42. C. T. Judkins, "an invention of new alloys."

1,140. P. Bourne, "an improvement in miners' lamps."

485. W. H. Gauntlett, "improvements in apparatus for heating the blast in the manufacture of iron."

342. J. Cameron, "improvements in the manufacture of iron and alloys of iron."

1,704. J. Thomas, "improvements in treating ores and earths containing iron, in order to obtain the metal therefrom."

### Patents on which £50 has been Paid.

1,290. T. Paddin, W. Lowther, "improvements in coke ovens."—Communicated from H. Eatin, France.—(24th May, 1860.)

1393. J. Saunders and J. Piper, "improvements in the manufacture of tin and terne plates."—(6th June, 1860.)

1337. W. R. Bowditch, "improvements in the purification of coal gas and of coal oils."—(31st May, 1860.)

1,492. G. Hinton, "improvements in cupola furnaces."

1,660. F. C. Warlich, "improvements in the manufacture of artificial coal fuel, and in apparatus employed in such manufacture."

### Patents on which £100 has been Paid.

1,255. C. Cowper, "improvements in the treatment of coal, and in purification, desiccation, and agglomeration of coal, and in machinery and apparatus for such purposes."—(26th May, 1856.)

1,292. Henry Bessemer, "improvements in the manufacture of iron of steel."

1,810. W. E. Newton, "a new or improved process for obtaining aluminium."

### Patents which have become Void by the non-payment of the Duty of £50. (1860.)

1,162. G. Holcroft, "certain improvements in the manufacture of iron."

1,240 C. Binks, "improvements in treating certain manganese compounds for obtaining oxides of manganese and other products therefrom."

1,409. J. Wright, "an improved apparatus for washing and separating metals, or their ores, from impurities or other foreign matters which are mixed with them."

1,673. J. Davis, "improvements in apparatus for the prevention of accidents at mines or pits."

### Patents which have become Void by the non-payment of the Duty of £100. (1856.)

1,180. J. Brown, "new and improved machinery to be used in the manufacture of iron."

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## AUSTRIA.

### Patents delivered in March and April, 1863.

111. E. Leyser and F. Stehler, "improvements in cylinder blasts for high and low pressure."

121. C. G. Müller, "a cement for conglomerating coal and brown coal."

148. E. L. Mönnich, "improvements in furnaces for the manufacture of oxides of zinc."

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## BELGIUM.

### Patents delivered in May and June.

14,168. The Vieille-Montagne Company, "applying Siemens' gas-heating process to furnaces for the reduction of zinc-ore."

14,189. C. W. Siemens, "improvements in apparatus for heating atmospheric air, and obtaining gas, applicable to the reduction of iron ore."

14,229. F. J. Cavenaile, Brussels, "improvement in miners' lamps."

14,235, G. Borguet, "improvements in Mueseler's lamps."

14,276. Chadefaud, "a moveable conical distributor for filling blast furnaces for the manufacture of sheet iron."

14,285. M. Motte, "a method of puddling iron and steel."

14,298. A. Muller & Co., "improvements in the direct process of manufacturing cast and wrought iron and steel."

14,316. J. B. Monsallie, "a twyer."

14,321. A. E. Dupont, "a mode of utilising metal contained in the residue from the manufacture of zinc."

14,347. L. N. Langlois, "apparatus for separating ores from their gangue."

14,354. E. Sonstadt, "improvements in the manufacture of magnesium."

14,374. H. Descole, "double-action fire-places of metallurgical gas furnaces."

14,378. A. Learch, "improvements in the manufacture of cast iron and steel."

14,389. L. J. Morton, "improvements in the treatment of mineral oils and hydro-carburets."

14,397. P. Denis, "cupola blasts."

14,398. Thou, "a petroleum lamp for miners."

14,400. N. Larmoyeux & H. Durant, "arrangements of petroleum lamps for miners."

14,435. J. Lipinsky, "a manufacture of white of zinc."

14,475. N. Marck, "a twyer cooled by the blast."

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## FRANCE.

### Current List of Patents, 1862.

56,169. Martin, sen. and jun., "an apparatus for burning, reducing, smelting, &c., ores, lime, and for other purposes."

56,259. Dufournel, "a process of refining pig-iron to be converted into iron for steel, by plunging pieces of wood into the smelted ore."

56,404. Wall, "improvements in purifying lead for extracting and separating silver, &c."

56,427. Mennesson, "applying steam with atmospheric air by the blast of furnaces."

56,706. Petin, Gaudet & Co., "improvements in apparatus for converting pig-iron into steel or iron."

56,727. Martin, "manufacture of cast steel."

56,735. De Rostaing and Baudouin, "a cupola-furnace for smelting ores and metals, and especially for the manufacture of cast steel."

56,737. Sudré, "manufacture of cast iron and steel by blowing various gases and vapour through the liquid mass, for the purpose of decarburetting, purifying, or recarburetting the metal."

56,806. Domingo, "applying electro-metallurgy to copper ores, for extracting copper and silver from ores."

56,844. G. Demàrest, "applying Siemens' furnaces to metallurgy."

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## PRUSSIA.

### Patents granted between 1st and 31st May, 1863.

5. Hasenclever, for "manufacture of chloride of barium."
7. M. Boner for "an apparatus for charging zinc furnaces."

10. K. Kremer, for "a sifting apparatus in continuous buddles for washing coals and other minerals."

## SWEDEN.

### Patents delivered during the Year 1862.

7. Muller & Co., for "a process and furnace for the treatment of zinc ores."
16. C. A. Angstrom, for "a so-called safety-pipe or barrel for miners in blasting or firing mines."
21. A Malcolm, "manufacture of fuel from small coal and charcoal."
23. A. Nuger, for "improvements in the construction of blast furnaces for any gaseous fuel combined with blasts."
28. H. Dillner, for "gas furnaces with blasts."
36. O. H. Dahlberg, for "obtaining white chalk and other substances from lime."
40. J. W. Nystrom, for "improvements in the construction of furnaces for converting cast iron into steel and malleable iron."
47. H. Biebuyck, for "improvements in the manufacture of blasting and other gunpowder."
62. T. Ramsay, for "improvements in the manufacture of coke."
64. E. B. Wilson, for "an apparatus for the manufacture of malleable iron and steel."
71. J. C. Schemman, for "manufacture of raw steel, cast steel, and refined steel from all kinds of cast iron."
79. E. B. Wilson, "improvements in and apparatus for the manufacture of iron and steel."

## UNITED STATES.

### Patents issued from 24th March to 19th June.

38,186. G. W. Sweet, for "an improved furnace for smelting ores, and for other purposes."

38,248. W. Stark, for "improvements in operating rolls for rolling iron."

38,301. M. G. Farmer, for "improved alloys of aluminium."

38,504. J. C. Schemman, for "improvement in the manufacture of steel."

38,513. J. E. Stileman & Z. Ellis, for "improved melting and smelting furnace."

38,758. J. W. Patterson, for "an improved process of utilising the tin from tin-plate chippings."

38,906. L. G. Marshall, for "an improvement in furnaces for reducing and smelting ores."

39,078. G. W. Sweet, "an improvement in purifying iron and steel by means of blasts of air."

# Mining, Quarrying, and Metallurgical Review.

## WESTERN COUNTIES.

Things generally have been dull all through the past month and there is nothing new to notice. The copper standard has on the whole advanced upwards of 4*l*. during the month, but the tin standards have been reduced 2*l*.

It is reported that Mr. W. Horton Davey, eldest son of Mr. Stephen Davey, of Redruth, and Mr. Richard Bain, of London, have become partners with Mr. John Michael Williams, of Pengreep, in the copper smelting company of William Foster and Co. of Burncoose and Swansea. Our readers may remember that the disputes which ended in the dissolution of partnership between the Messrs. Williams originated to some extent in the desire of Mr. John Michael Williams to introduce his brother-in-law, Mr. William Horton Davey, into the firm, which was then objected to by the other partners.

The annual meeting of the Royal Cornwall Polytechnic Society is advertised to take place at Falmouth on the 15th of September next.

A large meeting of the *West Chiverton* shareholders was held on the mine on July 23rd, when the accounts showed a profit on the three months' working of 2,353*l.*

A testimonial of the value of upwards of 500 guineas, subscribed for by the mining interest of the county, was presented to Mr. William Williams, of Tregullow, on July 14th at Redruth.

There are at present only two lead-smelting works in Cornwall, at Par, belonging to Messrs. Treffry and Co., and at Point, near Truro, belonging to Messrs. R. Michell and Son. The supplies of lead ore are chiefly drawn from the Cornish mines, but cargoes are occasionally received from Aberystwith, Teignmouth, Plymouth, &c., and occasionally from Antwerp.

At *Wheal Jane* meeting (June 22nd) it was resolved to accept Wheal Tremayne sett on the terms offered. At *East Basset and Grylls* preliminary meeting (June 18th) it was resolved that the mine should be conducted on the cost-book system. At *East Carn Brea* meeting (June 23rd) the appointment of Mr. George Lightly as pay clerk, in place of Mr. R. Lyle, deceased, was confirmed. At *Wheal Kitty* (Lelant) meeting (July 7th) it was resolved that the London office of reference be abandoned. At *East Caradon* meeting (July 8th) it was resolved to limit the inspection days to one day in the month. At *North Busy* meeting (July 2nd) it was resolved to stop the mine and sell the materials, the adventurers having lost about 10,000*l.* At *St. Day United* special meeting (July 9th) it was resolved to divide the sett, and work Wheal Gorland as a separate adventure. At *Wheal Emily Henrietta* meeting (July 20th) it was resolved to subdivide the shares into 4,096.

The dispute between *Tincroft* and *Cook's Kitchen* has been at last settled, the latter mine paying 1,800*l.* as full compensation to the former. To meet this a call of 15*s.* per share was made at *Cook's Kitchen.*

For some years there has been a chronic feud between the committee of management of the *Bedford United Mines* and a section of the shareholders residing at Exeter. The committee consists of Mr. W. A. Thomas (chairman of the board of directors of Devon Great Consols), J. Thomas, P. E. Blakeway and Charles Bailey, all gentlemen of well known character and position. The Exeter shareholders are represented by a sub-committee consisting of Messrs. S. S. Bastard, G. Down and W. Mortimer—the two latter being sharebrokers at Exeter. We have just received two reports addressed to the shareholders from each of these bodies, the tone of which we regret to observe is more hostile than ever, and indeed has become almost personal. The objects of the dissentient shareholders are not very clear, but the principal points in dispute seem to be—as to the construction of a branch railway to adjoin the Devon Consols line; the removal of the offices from London to Exeter; and the salary paid to Mr. Wolverstan, the purser and manager. On none of these points does the Exeter sub-committee appear to make out a case stronger than might be set up in the case of four-fifths of the Cornish mines; and it seems to us that the whole dispute is frivolous and is conducted in a spirit which should be strongly

condemned. To the two reports is appended a separate letter to the shareholders from Mr. W. A. Thomas.

The new concerns announced this month in these counties are the *Concord Silver and Copper Mining Company*, limited, with a proposed capital of 30,000*l.*, in shares of 3*l.* each, the object being to purchase and work a mine near Tavistock. The *West Polbreen Tin Mining Company*, with a proposed capital of 6,000*l.*, in shares of 1*l.* each. The object being to purchase and work a sett in St. Agnes parish. The *East Great Work Tin Mining Company*, with a capital of 30,000*l.*, in shares of 5*l.* each, proposes to purchase and work a sett in Breage parish. Lastly, the *Caradon and Phœnix Consols Mining Company*, with a capital of 2,500*l.*, proposes to work a sett near Liskeard, formerly known as Berriow Consols.

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## WALES AND THE BORDERS.

South Wales.—The iron trade of this district has been in a very satisfactory state all through the month, and the ironmasters seem to entertain a very promising opinion of the future. An additional furnace has been blown in at Cwmbran by Messrs. Roper and Co., which will give employment to a number of hands. At many of the works, however, considerable difficulty has been experienced in replacing the hands who continue to emigrate. The shipments of iron for the last month have reached nearly 15,000 tons, being about 7,000 tons more than the average, and if this continues for any length of time, the stock on the wharves will be completely cleared.

The tin works of the district have been also better employed, and those works that produce charcoal plates are able to report a little improvement, although not to any very satisfactory extent.

The coal trade has been as active as can be expected at this season of the year. The Risca collieries have not yet commenced working, which keeps several hundred hands out of employment. The continued scarcity of tonnage also interferes with the trade to a considerable extent.

The statistical returns of the trade of Swansea for the month of June have just been published by the trustees of the harbour, and from these we find that the total number of vessels which cleared out in that month was 543, with an aggregate registered tonnage of 58,425 tons. The shipping rate received were 1,409*l.* 5*s.* 3*d.*, and the total receipts of the harbour for the month over 3,600*l.* Comparing the trade of June with that of the corresponding month of 1862, we find an increase of 97 ships, 10,130 tons, and 239*l.* 16*s.* 10*d.* tonnage rates. The number of ships which cleared out for the first six months of the present year was 2,801, with an aggregate registered tonnage of 320,706 tons, and the total tonnage rates received, 7,879*l.* 17*s.* 5½*d.* As compared with the returns of the first six months of 1862, these figures show a satisfactory and steady increase.

From the returns published of the state of trade at Neath, we find that during the month of June the total number of vessels which cleared out was 291, with an aggregate registered tonnage of 20,575 tons, showing a considerable increase on the corresponding month of 1862.

A company called the *Palleg Anthracite Colliery Company* has been formed for the purpose of purchasing and developing the colliery of the same name, situated in the Twrch Valley, near Swansea. The proposed capital is 20,000*l.*, in shares of 4*l.* each.

Cardiganshire.—The prospectus of the *Blaencennant Silver-lead Mining Company* has been issued, with a capital of 25,000*l.*, in shares of 1*l.* each. The object of the proposed company is to purchase and work the silver-lead mine of the same name at Llanfihangel, near Aberystwith.

MERIONETHSHIRE.—The *Castell Carn Dochan Gold Mine* has fallen into the hands of a Manchester company, with a capital of 60,000*l.*, in shares of 1*l.* each. The secretary, Mr. T. A. Readwin, states that the lode at this mine is one of the richest gold discoveries in Merionethshire.

The prospectus of the *Great Cader Idris Lead, Copper, Iron Mining, and Slate Company*, limited, has been issued. This company is formed for the purpose of purchasing an extensive grant of lead, copper, iron ore, and slate, on the north side of the Cader Idris Mountain, known as the Cyfannedd-fawr, in the parish of Llanegryn.

GLOUCESTERSHIRE.—Among the imports into Bristol during the month have been :—50 tons of silver-lead ore from Plymouth, and 66 tons from Aberystwith ; 1,356 tons of sulphur ore from Arklow, 280 tons from Pomaron, and 315 tons from St. Ubes ; 104 barrels of sulphur from Liverpool ; 37 casks of metal from Rotterdam ; 255 tons of pyrites from Santander ; 150 tons of coprolite and 20 sheets of lead from Liverpool ; 2,726 bars of iron from Gothenburg ; 715 tons of pig-iron from Glasgow and Belfast ; 85 tons of lead ore from Newquay ; and 40 tons of tin-plates from Newport. Among the exports were 900 tons of coal ; 376 tons of iron ; and 5½ tons of tin-plates.

The imports into Gloucester have comprised :—400 tons of sulphur ore from Pomaron ; 112 tons of iron ore from Fowey ; and 100 tons of coal from Milford. Among the exports have been 1,000 tons of iron for Quebec, and 124 tons for Valencia.

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## MIDLAND COUNTIES.

STAFFORDSHIRE AND WARWICKSHIRE.—Trade in this district has been inactive. The chief demand has been for corrugated iron for galvanising purposes, a large quantity of which is required for home use as well as for export. The pig-iron trade has been very dull, and scarcely any orders have been booked. It is feared that the puddlers strike is increasing instead of diminishing, nor does there seem much chance of its terminating soon.

The quarterly meetings of the ironmasters of the Midland Counties have been held during the month. At the Wolverhampton meeting, on the 8th, the attendance was unusually small, and there was little disposition to do business. The principal transactions reported were in bars and sheets, but the demand was so slack that comparatively few makers obtained trade prices. Pig-iron was in moderate demand. The number of furnaces in blast was less than three months' ago, but prices had rather gone back. The general trade of the district was reported as being pretty good.

At the Birmingham meeting, on the 9th, the attendance was large, a much better feeling was shown on the part of consumers than at Wolverhampton, and a fair amount of business was done. The puddlers' strike formed the subject of discussion, but no one could see any prospect of a termination of this difficulty. The transactions in pig-iron, the make of the district, were on a moderate scale. Best hot-blast obtained scarcely such good prices as on last quarter-day, the top quotation being about 5*l.* 5*s.* per ton. The trade in Shropshire iron was steady, and the contracts entered into will keep the furnaces going through the greater part of the quarter.

At the Dudley meeting, on the 11th, a few transactions were reported in the better class of mine pig-iron at prices about the same as those given at Birmingham ; 3*l.* 5*s.* per ton seeming to be the highest price obtained for hot-blast iron. Ironstone was in good demand, at the same prices as three months' ago.

The coal trade has been extremely dull, and a number of pits have only been half working.

## NORTHERN COUNTIES.

Northumberland and Durham.—The reports of the iron trade are very satisfactory, and the demand seems to be fully equal to the supply. The various new works have been pushed forward with vigour, and considerable additions have been made during the present month. Messrs. Bell Brothers are erecting two new furnaces at their Clarence Works, where they have six already in operation, and the South Bank Company are about to add three more to their present stock.

It is reported that large and extensive rolling mills are about to be erected in the neighbourhood north of Monkwearmouth. It is also stated that a number of gentlemen in Sunderland propose to purchase the Bishopwearmouth Iron Works, and to re-open them.

It is stated that a valuable deposit of hematite iron ore has been discovered by Messrs. Kennedy Brothers, of Ulverstone, on the Greenscow estate near Dalton. The quality of this iron is said to be equal to that of the best ore of Furness.

The following figures show the state of the blast furnaces in the Cleveland district on the 1st July:—

| Places and Owners. | In. | Out. | Total. |
|---|---|---|---|
| Eston — Bolckow and Vaughan .. .. .. | 9 | — | 9 |
| „ Clay Lane Company .. .. .. | 3 | — | 3 |
| „ South Bank Company .. .. .. | 3 | — | 3 |
| Cargo Fleet—Jones, Dunning and Co. .. .. | 2 | — | 2 |
| „ Cochrane and Company .. .. | 4 | — | 4 |
| „ Gilkes, Wilson, Pease and Co. .. | 4 | 1 | 5 |
| Middlesborough—Bolckow and Vaughan .. .. | 3 | — | 3 |
| „ Hopkins and Co. .. .. | 2 | — | 2 |
| Port Clarence—Bell Brothers .. .. .. | 5 | 1 | 6 |
| Norton—Warner, Lucas and Barrett .. .. | 3 | — | 3 |
| Stockton—Holdsworth and Co. .. .. .. | 3 | — | 3 |
| Ferry Hill—J. Morrison .. .. .. .. | 3 | — | 3 |
| Thornaby—W. Whitwell and Co. .. .. .. | 3 | — | 3 |
| Darlington—South Durham Company .. .. | 3 | — | 3 |
| Whitton Park—Bolckow and Vaughan .. .. | 4 | — | 4 |
| Stanhope—Weardale Iron Company .. .. | — | 1 | 1 |
| Towlaw—Weardale Iron Company.. .. .. | 4 | 1 | 5 |
| Consett—Derwent Iron Company .. .. .. | 5 | 13 | 18 |
| Total .. .. .. .. | 63 | 17 | 80 |
| All places, July 1st, 1858 .. .. .. .. | 49 | 14 | 63 |
| „ „ 1859 .. .. .. .. | 54 | 13 | 67 |
| „ „ 1860 .. .. .. .. | 52 | 22 | 74 |
| „ „ 1861 .. .. .. .. | 49 | 27 | 76 |
| „ „ 1862 .. .. .. .. | 54 | 25 | 79 |

The coal trade still continues dull, although there is a slight improvement on last month's reports. A scarcity of tonnage for the Thames has been felt, in consequence of some of the colliers usually employed in the London trade having gone into the Baltic trade.

A movement has been inaugurated among the principal merchants and others engaged in the trade, for the purpose of abolishing the "keel" measure on the Tyne, and substituting that of "ton." This is a change which has long been a necessity. The "keel" is, in many respects, an arbitrary measure, for, although expected to contain 8 chaldrons, of 53 cwts. each, these chaldron waggons have, in reality, often been made to carry 60 cwts., so that much underselling and general confusion is caused by this method of computation. The substitution of the standard "ton" will, therefore, be a great improvement. The parties interested have signed a document, setting forth the advantages to be derived from the proposed change, and this document has been signed by the largest mercantile and shipping firms in Newcastle, as well as by several of the colliery owners.

The exports from the Tyne during the month include:—218,140 tons of coal; 11,131 tons of coke; and 70,775 cwts. of iron. Among the imports have been:—cargoes of pyrites from Dordt, Levanger, Antwerp, Seville, Pomaron, Rotterdam, Cadiz, Drontheim, and Huelva; 1,315 bars of iron from Gothenburg, and 3,592 from Sefle; cargoes of manganese from Huelva, Dordt, Lalaja, and Pomaron; 11,638 bars of lead from Carthagena, and 1,219 bars from Almeira; 14 tons of yellow metal from Stavanger; copper ore from Lalaja, Levanger, and Carthagena; and two cargoes of iron ore from Cherbourg.

CUMBERLAND.—The *North Coniston Copper Mining Company*, limited, propose to purchase and work the Cockley Beck Copper Mines. The capital is to be 20,000*l*., in shares of 2*l*. each.

YORKSHIRE.—The coal trade has not shown any great amount of activity, and prices remain about the same as last month.

A prospectus has been issued of the *Whittington Freehold Colliery Company*, with a capital of 135,000*l*., in shares of 10*l*. each. The property consists of collieries near Sheffield, which are to be purchased for 30,000*l*. in cash, and 35,000*l*. in free shares.

## SCOTLAND.

Coals have been in limited demand for home use and for export, and the amount of business transacted at the different ports has been much under the corresponding period of last year.

The pig-iron market has a little declined, and transactions have been very confined. The following are the shipments during the first six months of the present year, as compared with the corresponding six months of 1862, 1861, and 1860:—

| Month. | 1863. | 1862. | 1861. | 1860. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| January.. .. .. .. | 30,467 | 47,729 | 39,267 | 38,625 |
| February .. .. .. | 38,867 | 39,614 | 33,070 | 26,883 |
| March .. .. .. .. | 50,909 | 44,495 | 33,474 | 39,152 |
| April .. .. .. .. | 57,345 | 53,160 | 62,622 | 50,585 |
| May .. .. .. .. | 67,820 | 70,461 | 82,036 | 66,701 |
| Week ending June 6 .. .. | 11,627 | 10,829 | 15,313 | 10,417 |
| " " 13 .. .. | 13,840 | 8,695 | 14,709 | 8,928 |
| " " 20 .. .. | 12,334 | 13,224 | 12,736 | 10,180 |
| " " 27 .. .. | 16,005 | 9,419 | 14,443 | 11,187 |
| Total .. .. | 299,214 | 294,626 | 305,670 | 262,658 |

**It will be observed that in June the exports made a great stride, as compared with June, 1862, having been 53,806 tons against 42,167 tons in that month, 57,201 tons in June, 1861, and 40,712 tons in June, 1860. At the close of May, the shipments were below last year's level, but they now slightly exceed it, and compare well with both 1862 and 1861. The shipments of the first two quarters of the four years may be compared as follows:—**

| | 1863. | 1862. | 1861. | 1860. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| First quarter .. .. .. | 120,243 | 128,838 | 103,811 | 104,660 |
| Second quarter.. .. .. | 178,971 | 165,788 | 201,859 | 157,998 |
| Total .. .. | 299,214 | 294,626 | 305,670 | 262,658 |

With the exception of the first quarter of 1861, the shipments of the past three months have probably never been exceeded in any former corresponding period.

## FOREIGN AND COLONIAL.

France.—There is no material variation in the state of the iron trade in the Haute Marne district. Pig has been firm at *5l.* *2s.*; rolled irons from charcoal pig have been held at from *9l.* *4s.* to *9l.* *12s.* The Closmortier rolling works, which have been stopped for repairs to the hydraulic machinery, have been again put into activity, all the furnaces having been re-lighted, while the establishment is about to be extended with a fourth furnace for heating purposes, and two puddling furnaces. New works are about to be erected at Longwy, in the department of the Moselle, by MM. Labbe and Legendre; the establishment will include, at least, three blast furnaces. It appears from an official return that 2,690 tons of special irons entered Paris in May, besides 1,563 tons of castings, showing an increase of 599 tons of iron and 90 tons of castings, as compared with May, 1862.

The ironworks of Framont, in the department of the Vosges, are to be offered to public competition, the reserve price being 5,600*l.* The establishment comprises also iron-stone workings, the rich bearings of iron and copper pyrites, and a blast furnace.

It is reported that a valuable deposit of iron ore has been discovered in the department of Allier.

Belgium.—The Belgian iron market has been rather more active, although quotations remain much about the same. The ironworks of the Liège district have been well supplied with orders for merchant's iron and bars. Business has been dull at Charleroi, and prices have been almost nominal.

Prussia.—A prospectus has been issued of the *New Mansfeld Copper and Silver Mining Company*, with a capital of 100,000*l.*, in shares of 10*l.* The object is to work the Mathilde mines, about forty miles from the city of Brunswick, which occupy an extensive area, and consist of copper-bearing schist, described to be analogous to that of the celebrated Mansfeld district. The price to be paid is 15,000*l.* in cash, and 25,000*l.* in shares.

The *Rhenish Consolidated Mining Company*, limited, with a capital of 60,000*l.*, in shares of *5l.* each, propose to work a quantity of mines yielding, lead, copper, silver-lead, blende, manganese, and iron ores.

The *Kyffhäuser Mining and Smelting Company*, limited, with a capital of 200,000*l.*, in 10,000 shares of 20*l.* each, has issued a prospectus. The property to be purchased adjoins that of the Mansfeld Copper Mining Company.

PORTUGAL.—A prospectus has been issued of the *Portugal Iron and Coal Company*, with a capital of 100,000*l.*, in shares of 10*l.*, to develop a district of rich iron ore and coal, for which concessions have been granted by the Portuguese Government. The price to be paid is 6,000*l.* in cash, and 33,330*l.* in paid-up shares.

AUSTRALIA.—The following advices were brought by the Australian mail from the various mining companies at *Kapunda*:—the quantity of ore raised in February was 210 tons, of 15 per cent. average produce, equal to 31¾ tons of pure copper. And the quantity raised in March is estimated at 280 tons, of which the samples were not all settled, but the average produce will be higher than the previous month. The smelting furnaces were in full operation, but in consequence of the scarcity of freight only very trifling shipments are advised by this mail.

At *Worthing*, the lode in the engine shaft had improved, and the ore was of richer quality than the average.

At *English and Australian* there were three furnaces and one refinery at work at Kooringa, and four furnaces and one refinery at work at the Port works. A shipment of 40 tons of copper had been made to India.

The reports from *North Rhine* and *Great Northern* were very discouraging.

# Record of the Mining and Metal Markets.

## METALLIC-ORE MARKETS.

TIN.—The standards for black tin were reduced 2*l.* on July 24th, and now stand at—

| | | | |
|---|---|---|---|
| Superior Fine | .. £115 .... | Superior Common | .. £110 |
| Second Fine | .. 112 .... | Second Common | .. 109 |

COPPER.—At the four Cornish sales we give this month, the number of tons, average produce, quantity of fine copper, average price per ton, and standard have been as follows:—

| *Date.* | *Tons.* | *Produce.* | *Fine Copper.* Tons. cwt. | *Price per ton.* | *Standard.* |
|---|---|---|---|---|---|
| June 25. | 2,667 | 7½ | 192 16 | £5 9 0 | £113 2 0 |
| July 2. | 3,084 | 7 | 215 6 | 5 8 0 | 116 15 0 |
| „ 9. | 1,860 | 6⅞ | 128 0 | 5 8 0 | 118 7 0 |
| „ 23. | 5,890 | 6 | 350 11 | 4 10 6 | 122 6 0 |

At the sale of the 25th the standard advanced £1 13*s.*; at that of the 2nd it advanced 2*l.* 7*s.*, and again at that of the 9th 1*l.* 8*s.*, making in all an advance of 5*l.* 8*s.* At the sale of the 23rd the standard declined 1*l.* 1*s.*

LEAD.—Comparing this month's sales with those of last, we find that prices are, on an average, about the same.

## COAL MARKETS.

LONDON, *July* 31*st.*—From the returns of the Registrar of the London Coal Exchange, of the quantity of sea-borne coal, culm, and cinders, imported into London in the month of June, we learn that the total

quantity was 1,577,827 tons, against 1,663,173 tons during the corresponding month of last year, showing a *decrease* of 85,346 tons.

The following are the particulars of the 1,577,827 tons imported during June:—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Newcastle .. | 78,396 tons, in | 189 ships | | Scotland .. | 1,398 tons, in | 6 ships |
| Seaham .. | 17,928 „ | 70 „ | | Wales .. | 13,028 „ | 32 „ |
| Sunderland . | 61,394 „ | 141 „ | | Yorkshire .. | 3,175 „ | 29 „ |
| Middlesbro'. | 4,351 „ | 16 „ | | Small .. | 2,050 „ | 6 „ |
| Hartlepool.. | 43,231 „ | 156 „ | | Cinders .. | 1,076 „ | 5 „ |
| Blyth .. | 540 „ | 2 „ | | | | |

The London coal market has been pretty active all through the month. On the 1st, the ships arrived were 102—market dull. The prices were: Hetton Wallsend, 17*s.* 3*d.*; Braddyl's Wallsend, 15*s.* 3*d.*; Lambton Wallsend, 16*s.* 6*d.*; Eden Main, 14*s.* 6*d.*; Butes Tanfield Moor, 13*s.*; Tees Wallsend, 16*s.* 6*d.*; Stewart's Wallsend, 16*s.*; South Kelloe Wallsend, 14*s.*; Hasting's Hartley, 14*s.* 9*d.*; West Hartley, 15*s.* On the 3rd, new ships 27, market firm. On the 6th, new ships 58, market active. On the 8th, new ships 21, market steady. On the 10th, new ships 17, market firm. On the 13th, new ships 74, market dull. On the 15th, new ships 68, prices advanced 3*d.* per ton. On the 17th, new ships 53, another advance of 3*d.* On the 20th, new ships 81, market active. On the 22nd, new ships 21, market steady. On the 24th, new ships 21, market quiet. On the 27th, new ships 71, market firm. On the 29th, new ships 24, market dull. Hartley's advanced 6*d.* per ton. On the 31st, new ships 52, market stronger. The prices were: Hetton Wallsend, 18*s.*; South Hetton Wallsend, 17*s.* 9*d.*; Tees Wallsend, 17*s.* 3*d.*; Eden Main, 15*s.* 9*d.*; Gosforth Wallsend, 15*s.* 6*d.*; Bute's Tanfield, 13*s.*

LIVERPOOL.—From Messrs. J. and T. Platt's Coal Circular for July, we find that the quantity of coal, cannel, coke, and patent fuel shipped from Liverpool to foreign and colonial ports during the month of June was 648,267 tons, against 645,969 tons during the corresponding month of last year—showing an *increase* of 2,298 tons.

From the official returns we find that the shipments coastwise of coals, cinders, and culm during the year 1862, amounted to 10,874,276 tons, showing a *decrease* of about 100,000 tons as compared with 1861.

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## SHARE MARKETS.

LONDON, *July 30th.*—Dullness continues to be the prevailing feature of the mining market, and all through the month the amount of business transacted has been very limited. Some heavy failures are announced today, which have had a depressing effect.

A large portion of the attention of the mining market is still devoted to *East Caradon*, the shares in which, after almost daily fluctuations, close at an advance of about 3*l.* on our last quotation. They opened, on the 30th, at 26½*l.*-27*l.*, at which price they were very flat, and receded until the 2nd, when they were at their lowest price, 25¾*l.*-26¼*l.* They advanced a little again on the 3rd, and fluctuated between 27*l.* and 29*l.* until the 21st, when they were quoted at 29*l.*-30*l.* On the 28th they reached their highest price, 33*l.*-33½*l.*, since which they have been depressed, and have declined 2½*l.*, closing at 30½*l.*-31*l.* There has been a very heavy bear account in these shares for the last two accounts.

*Marke Valley* shares have been a good deal dealt in during the month, but prices have only fluctuated between 6¼*l.* and 6¾*l.*, closing at our last quotation of 6*l.*-6½*l.* *South Caradon* shares have advanced 10*l.* per share during the month. They opened 405*l.*-410*l.*, and on the 16th had advanced

to 420*l.*-430*l.*, but receded again, closing at 415*l.*-420*l.* *West Caradon* shares have declined from 24*l.*-25*l.* to 22*l.*-24*l.*

*East Basset* shares have receded about 4*l.* per share during the month. They opened 82*l.*-83*l.* On the 10th they had gone down to 74*l.*-76*l.*, at which price they were dull, with sellers. They fluctuated between 75*l.* and 77*l.* until the 20th, when they were 77½*l.*-79*l.* After advancing to 79*l.*-81*l.* on the 22nd, they again went back, closing at 76*l.*-78*l.* *Copper Hill*, 75*l.*-80*l.*

*North Basset* shares have slightly declined during the month. They opened 3½*l.*-3¾*l.*, and close 3¼*l.*-3½*l.* *Wheal Basset*, 65*l.*-70*l.* *Wheal Buller*, 50*l.*-52½*l.*

Business in *Great Wheal Fortune* shares has been limited, and prices have slightly declined. Shares opened at 35⅛*l.*-36⅛*l.*, and close 34*l.*-35*l.* *Wendron Consols*, 10*l.*-12*l.* *Wheal Basset and Grylls*, 22½*l.*-23½*l* *Wheal Sithney Carnmeal*, 5½*l.*-5¾*l.*

*Tincroft* shares have remained between 21*l.* and 22*l.* all through the month, closing at 21½*l.*-22*l.* *North Roskear* shares have been again neglected. They opened 23*l.*-25*l.*, and close 22*l.*-23*l.* Some business has been transacted in *Cook's Kitchen*, and shares at one time advanced to 28*l.*-30*l.*, but receded again to the opening price of 26*l.*-27*l.* *Stray Park* shares have been dealt in, and have advanced from 36*l.*-37*l.* to 40*l.*-41*l.* *Wheal Harriett* shares have been dull, and have receded from 2⅜*l.*-2⅝*l.* to 1¾*l.*-1⅞*l.* *North Crofty*, 3½*l.*-4*l.* *Wheal Grenville*, 6*l.*-6½*l.* *Wheal Crofty*, 2¾*l.*-3¼*l.*

*Wheal Seton* shares have declined another 10*l.* during the month. They opened 225*l.*-230*l.*, but never reached that price again after the 4th, and close at 215*l.*-220*l.* *East Carn Brea* shares have been pretty steady at 7¾*l.*-8¼*l.* *Clifford Amalgamated* shares have again slightly advanced. They opened 25*l.*-26*l.*, and close 27*l.*-28*l.* *West Tolgus* shares have declined all through the month, and have receded 16*l.* per share on our last quotation. They opened 73*l.*-75*l.*, and close 57*l.*-60*l.* *South Tolgus*, 40*l.*-45*l.* *North Grambler*, 4*l.*-4¼*l.* *West Chiverton* shares have advanced from 24*l.*-25*l.* to 26*l.*-27*l.* *Cargoll*, 40*l.*-41*l.* *Wheal Ludcott and Wrey Consols* shares have again steadily declined all through the month. They opened 4*l.*-4⅛*l.*, and close 2⅞*l.*-3⅛*l.* *Wheal Mary Ann*, 12½*l.*-13½*l.* *Wheal Trelawny*, 16*l.*-17*l.* *Herodsfoot* have dropped from 42*l.*-44*l.* to 40*l.*-42*l.*

*Wheal Margaret* shares have slightly receded. They opened 33*l.*-35*l.*, and close 32½*l.*-33½*l.* *Wheal Kitty* (St. Agnes) shares have advanced from 7¼*l.*-7½*l.* to 8⅝*l.*-8⅞*l.* *Providence*, 41*l.*-42*l.*

*Wheal Crebor* shares have dropped from 2*l.*-2¼*l.* to 1¾*l.*-2*l.* *Drakewalls*, 1½*l.*-1¾*l.* *Bottle Hill* shares have advanced from 11*s.*-13*s.* to 15*s.*-17*s.* 6*d.* *Wheal Edward*, 2⅝*l.*-2⅞*l.* *East Russell*, 4¼*l.*-4½*l.*

Transactions are also reported in the following mines:—*Gonamena*, 1⅞*l.*-2⅛*l.* *Rosewall Hill* and *Ransome United*, 3*l.*-3¼*l.* *Kelly Bray*, 17*s.* 6*d.*-20*s.* *North Robert*, 15*s.*-17*s.* 6*d.* *Wheal Unity*, 12*s.*-14*s.* *West Rose Down*, 7*l.*-9*l.* *North Dolcoath*, 2*l.*-2¼*l.* *North Treskerby*, 3*l.*-3¼*l.* *North Downs*, 2⅛*l.*-2⅜*l.* *North Buller*, 6½*l.*-7½*l.* *New Wheal Martha*, 3½*l.*-3¾*l.* *Glasgow Caradon Consols*, 3*l.*-3¼*l.*

In Welsh mines *Longrake* has been quoted at 16*l.*-18*l.* *Bryn Gwiog*, 30*l.*-31*l.*

In colonial and foreign mines business has been done at the following prices:—*Alamillos*, ⅝*l.*-¾*l.* *Cape Copper*, 4⅜*l.*-4¼*l.* *Capula Silver*, ½*l.*-⅝*l.* *Cobre Copper*, 30½*l.*-31½*l.* *Copiapo*, 30¼*l.* *Don Pedro North Del Rey*, 1⅛*l.*-1¼*l.* *Pontgibaud*, 2⅝*l.*-2¾*l.* *Santa Barbara*, ½*l.*-⅝*l.* *St. John del Rey*, 53½*l.*-55½*l.* *United Mexican*, 6⅞*l.*-7*l.* *Vallanzasca*, 1⅜*l.*-1½*l.*

DUBLIN.—The Irish mine share market has been quiet all through the month, although a fair amount of business has been transacted. *Wicklow Copper* shares have been in demand, and have advanced from 37*l.* to 41*l.* 5*s.*, at which they close. *General Mining Company for Ireland*, 4*l.*-5*l.* *Mining*

*Company of Ireland*, 19*l*. 2*s*. 6*d*.-19*l*. 5*s*. *Connorree*, 17*s*. 6*d*. *Carysfort*, 21*s*. 6*d*.

CORNWALL.—The Cornish mine share market has been rather inactive, and transactions have been limited. *South Crofty* shares have again slightly receded to 24*l*.-25*l*. *Condurrow* shares have declined 10*l*. per share, from 105*l*.-110*l*. to 95*l*. *West Tolgus* shares have had a heavy fall, and have receded 16*l*. per share on our last quotation, closing at 57*l*. *Wheal Reeth*, 37*l*.-39*l*. *Emily Henrietta*, 9¾*l*.-10*l*.

## METAL MARKETS.

LONDON, *July 30th*.—The metal market which was pretty active at the beginning of the month became very quiet later on, and at the close of the month a very small amount of business was done.

IRON.—The iron trade has been steady, and prices have had an upward tendency.

Scotch pig-iron advanced from 51*s*. 9*d*. to 55*s*. 3*d*., but declined again to 53*s*. 10½*d*.

Welsh bars have been firm at 5*l*. 15*s*. to 5*l*. 17*s*. 6*d*. at the works, and 6*l*. 5*s*. to 6*l*. 10*s*. f. o. b. in London. Staffordshire descriptions have been in good demand at full prices. Swedish bars have been neglected, and have with difficulty realised from 11*l*. 5*s*. to 11*l*. 10*s*. ordinary specifications.

STEEL.—Swedish keg and faggot have been dull of sale; small quantities of keg have realised 16*l*. 10*s*.

COPPER.—The market for English, both raw and manufactured, has been quiet but firm, and on the 27th the smelters advanced the price of English, both raw and manufactured, 3*l*. per ton. Burra Burra, 100*l*. Kapunda, 102*l*. Spanish, 91*l*. Chili, 87*l*.

YELLOW METAL.—This article has been advanced ¼*d*. per lb.; braziery sheets, 8¼*d*.; sheathing, 9*d*.

TIN.—The market for English has been dull, very little business has been transacted, and on the 24th the smelters announced a reduction in fixed rates of 4*l*. per ton, making present prices 124*l*. for refined, common 118*l*.

In foreign nothing has been doing, and prices are nominal. Banca, 127*l*. Straits, 122*l*. The Dutch market has been dull at 74½ fl.

TIN PLATES.—There is no change in this article, and prices remain unaltered.

LEAD.—This metal has been dull of sale at rather reduced prices. Good soft English, 20*l*. 5*s*.-20*l*. 12*s*. 6*d*.; W. B., 22*l*. 10*s*.

SPELTER.—About the middle of the month a large business was done in this article at advanced prices. On the spot, 18*l*. 5*s*.-18*l*. 10*s*., for forward delivery.

GLASGOW, *July 23rd*. IRON.—The pig-iron market opened rather flat, but became very brisk in the middle of the month, and prices advanced from 51*s*. 9*d*. to 55*s*. The American news, however, checked this activity, and prices fell to 53*s*. The exports for the five weeks ending July 23rd amounted to 72,341 tons, against 54,381 tons during the corresponding period of 1862—showing an increase of 17,960 tons.

BERLIN, *July 17th*. IRON.—Scotch pig-iron has been in active demand, and prices have advanced. Iron in bars from 3⅝-4 thlrs. Staffordshire descriptions, 5 thlrs.

TIN.—There has been little doing in this metal, and prices have declined. English, 40 thlrs. Banca, 46 thlrs.

COPPER.—The market for this metal has been very firm, and a rise in prices shortly expected. Burra Burra, 33 thlrs. Demidoff, 36 thlrs. Best selected, 32 thlrs.

LEAD.—This article has been quiet at unaltered prices.

SPELTER.—The market for this article has been firm, and closing prices show a rising tendency; W. H., 5¼ thlrs.

HAMBURG, *July* 16*th*. IRON.—Scotch pig-iron, 2⅛-2¼ marks. Iron in bars, 5-5⅛ marks. Staffordshire descriptions, 5⅞-6⅛ marks.

COPPER.—The demand for this metal has been limited, and prices remain unaltered. Demidoff, 72 marks. Lake Superior, 70 marks.

TIN.—English remains unaltered, but a little reaction has taken place in foreign. Banca, 14½-14¾ sch.

AMSTERDAM. COPPER.—This metal has been dull of sale at 52½fl.

TIN.—The market for foreign has been more buoyant. Banca, 76½fl.

AMOY, *May* 8*th*. LEAD.—300 pigs, W. B. mark, at 8 dollars 75 cents per picul.

HONG KONG, *May* 13*th*. LEAD.—At Canton prices have further declined 10 cents. Sales, 1,500 piculs. At Hong Kong, prices unchanged. Sales of pigs, at 7 dollars 20 cents to 7 dollars 50 cents.

IRON.—A better demand has existed. Quoted nailrod, 2 dollars 50 cents to 2 dollars 75 cents; hoop, 3 dollars 20 cents to 3 dollars 40 cents; bar, 2 dollars 60 cents to 4 dollars. Sales of all kinds, 5,300 piculs.

BOMBAY, *June* 24*th*.—Metals continue dull, the market being overstocked. All kinds of copper have maintained their former value, except nails, which are lower and neglected. Yellow metal sheathing has been in inquiry at better rates. Iron is dull, and prices are giving way. Of lead, supplies are too heavy for the present small demand, and rates are easier. Steel is dull and tending downwards. Spelter has receded a little in value. Tin plates and quicksilver are unchanged.

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*Furnished by Von Dadelszen and North*, 158, *Leadenhall Street, London, E.C.*

The course of the metal trade during this month presents us with but few features demanding particular remark; our market has been characterised by great quietude combined with much firmness in prices. In copper an advance of 3*l.* per ton has been made in the official prices of both raw and manufactured, whilst on the other hand the smelters have reduced the official price of English tin 4*l.* per ton all round.

IRON.—Welsh bars are in good demand at 5*l.* 15*s.* f.o.b. in Wales, and from 6*l.* 7*s.* 6*d.* to 6*l.* 10*s.* f.o.b. here. Staffordshire is also firm. Scotch pig iron has fluctuated from time to time, and closes at 53*s.* 6*d.* cash, 54*s.* 3*d.* three months, and with an upward tendency.

COPPER.—The smelters on the 27th instant advanced the price of English, both raw and manufactured 3*l.* per ton; second hand parcels are obtainable a trifle under official rates. For Burra, 100*l.* is asked; 102*l.* for Kapunda; Spanish, 91*l.* to 92*l.*; Chili, 87*l.*

TIN.—Nearly all the month this article has had a downward tendency without any disposition to rally, and closes at the lowest. On the 25th instant, the smelters reduced the official prices of English tin 4*l.* per ton all round. We quote Straits 122*l.*, and Banca 127*l.* The Dutch market is dull at 74½fl.

TIN PLATES.—In steady demand and unaltered in value.

LEAD continues dull of sale; good soft English from 20*l.* 5*s.* to 20*l.* 12*s.* 6*d.*

SPELTER.—This market has assumed the appearance of great firmness, and the price has advanced to 18*l.* 5*s.* for spot parcels; for forward delivery 18*l.* 10*s.* is firmly demanded. Hull parcels 18*l.* to 18*l.* 2*s.* 6*d.*, according to brand.

## PRICES CURRENT OF METALS.

From Messrs. James and Shakspeare's, 10, Austin Friars, E.C., *27th July*.

| | | | |
|---|---|---|---|
| | | | Per Ton. |
| IRON | Bars (Welch) .. in Wales .. | —— | @ £5 15 0 |
| | " " .. " Liverpool | £6 5 0 | " 6 10 0 |
| | " " .. " London | 6 10 0 | " 6 15 0 |
| | Nail Rods " .. " Wales . | —— | " 6 5 0 |
| | " (Staffordshire) " Liverpool | 6 15 0 | " 7 0 0 |
| | " " " London | 7 0 0 | " 7 10 0 |
| | Hoops " " Liverpool | 7 15 0 | " 8 2 6 |
| | " " " London | 8 5 0 | " 8 10 0 |
| | Sheets " " Liverpool | 8 12 6 | " 9 5 0 |
| | " " " London | 9 5 0 | " 9 10 0 |
| | Bars " " Liverpool | 6 15 0 | " 7 0 0 |
| | " " " London | 7 5 0 | " 7 10 0 |
| | Scotch Pig (No. 1. g.m.b.) the Clyde | 2 14 3 | " 2 14 6 |
| | Rails ................ in Wales | 5 15 0 | " 6 0 0 |
| | Swedish—Hammered—large sizes | 11 5 0 | " 11 10 0 |
| | " " Indian assortments | —— | " 11 10 0 |
| STEEL ........ | " " Hammered—faggot | 16 10 0 | " 17 0 0 |
| | " " in kegs (¼ and ⅝ in.) | 15 10 0 | " 16 0 0 |
| COPPER ...... Australian .. | Burra and P.C.C. ............ | —— | " 97 0 0 |
| | Kapunda .................. | —— | " 100 0 0 |
| | Wallaroo ................ | —— | " 97 0 0 |
| American.... | Baltimore .................. | 98 0 0 | " 100 0 0 |
| | Lake Superior ............. | —— | " none |
| | Spanish Cake................ | —— | " 90 0 0 |
| | Chili and other Slab (for 96 per cent. pure Copper) ........ | 86 10 0 | " 87 0 0 |
| English .... | Tough Cake and Ingot and Tile | —— | " 95 0 0 |
| | Best selected Ingot .......... | —— | " 98 0 0 |
| | Sheets, Sheathing and Rod .... | —— | " 102 0 0 |
| | Flat Bottoms................ | —— | " 107 0 0 |
| | | | Per lb. |
| YELLOW METAL.. | Sheets .................... | —— | @ 8¼*d.* |
| | Sheathing and Rod ........ | 8¾*d.* | " 9*d.* |
| | | | Per Cwt. |
| TIN ......... English .. | Common Blocks and Ingots .... | —— | @ 118*s.* |
| | " Bars (in barrels) ...... | —— | " 119*s.* |
| | Refined .................... | —— | " 124*s.* |
| Foreign .. | Straits, Fine ................. | 124*s.* | " 125*s.* |
| | " (with 3 months' prompt) | 125*s.* 6*d.* | " 126*s.* |
| | Banca ..................... | —— | " 130*s.* |
| | | | Per Box. |
| TIN PLATES at Liverpool 6*d.* Less | Charcoal IC, best.............. | 28*s.* 6*d.* | @ 29*s.* |
| | " IX " .............. | 34*s.* 6*d.* | " 35*s.* |
| | Coke IC .................. | 22*s.* 6*d.* | " 25*s.* |
| | " IX .................. | 28*s.* 6*d.* | " 31*s.* |
| | | | Per Ton. |
| LEAD........ English .. | Sheet ........................ | —— | @ £21 0 0 |
| | Pig—W.B. .................. | —— | " 21 15 0 |
| | " Other good brands ........ | 20 2 6 | " 20 7 6 |
| | " German and Spanish, soft .. | 19 15 0 | " 20 0 0 |
| English .. | Red ...................... | —— | " 21 10 0 |
| | Shot ...................... | —— | " 23 10 0 |
| | Dry White.................. | —— | " 26 0 0 |
| SPELTER ...... | (Silesian) in Cakes ........... | —— | " 18 7 6 |
| ZINC .......... | (Sheet) No. 9 and upwards .... | —— | " 23 5 0 |
| | | | Per Bottle. |
| QUICKSILVER | (in bottles containing 75lbs. each) | —— | @ 7 0 0 |
| | | | Per Ton. |
| ULUS OF ANTIMONY, | French Star ...... | —— | @ 39 0 0 |

# Tabular Abstract of Mining Accounts for the Month.

| Date of Account. | Name of Mine, and Number of Shares. | Balances. Debit. | Balances. Credit. | Calls. Per Share. | Calls. Total. | Dividends. Per Share. | Dividends. Total. |
|---|---|---|---|---|---|---|---|
| | | £ s. d. | £ s. d. | £ s. d | £ s. d. | £ s. d. | £ s. d. |
| | **CORNISH AND DEVON MINES.** | | | | | | |
| June 15 | Carn Brea (1,000) | — | 2,063 0 5 | — | — | — | — |
| ,, 16 | Garlidna (1,024) | 832 4 11 | — | 0 16 6 | 844 16 0 | — | — |
| ,, 18 | Falmouth and Sperries (2,000) | 76 10 8 | — | 0 5 0 | 500 0 0 | — | — |
| ,, 18 | West Condurrow (1,218) | 522 5 11 | — | 0 10 0 | 609 0 0 | — | — |
| ,, 18 | Wheal Rose (2,000) | 716 17 0 | — | 0 15 0 | 1,500 0 0 | — | — |
| ,, 22 | Wheal Jane (512) | 202 19 1 | — | — | — | — | — |
| ,, 23 | South Carn Brea (6,000) | 2,695 0 2 | — | 0 3 0 | 900 0 0 | — | — |
| ,, 23 | Cuddra (6,000) | 597 0 5 | — | 0 2 6 | 750 0 0 | — | — |
| ,, 23 | East Carn Brea (6,000) | — | 227 12 9 | — | — | — | — |
| ,, 23 | Wheal Union (6,000) | 317 19 9 | — | 0 2 0 | 600 0 0 | — | — |
| ,, 23 | Camborne Vean (4,600) | 1,016 8 8 | — | 0 5 0 | 1,120 0 0 | — | — |
| ,, 23 | Fowey Consols (940) | — | 942 19 0 | — | — | — | — |
| ,, 23 | East Providence (4,096) | — | 24 10 4 | 0 2 0 | 409 12 0 | — | — |
| ,, 23 | Carnyorth (2,048) | 803 8 11 | — | — | — | — | — |
| ,, 24 | North Basset (6,000) | 1 10 6 | — | 0 3 0 | 900 0 0 | — | — |
| ,, 24 | East Wheal Grylls (2,048) | — | 461 11 9 | — | — | — | — |
| ,, 24 | Wheal Grylls (1,024) | — | 1,189 4 5 | — | — | 1 0 0 | 1,024 0 0 |
| ,, 25 | Kelly Bray (5,000) | — | 200 0 0 | — | — | — | — |
| ,, 25 | Hingston Down (6,000) | — | 111 12 0 | 0 1 6 | 450 0 0 | — | — |
| ,, 25 | Furze Hill Wood (6,000) | 823 17 11 | — | 0 3 0 | 900 0 0 | — | — |
| ,, 25 | Okel Tor (4,096) | 337 17 7 | — | — | — | — | — |
| ,, 26 | St. Day United (4,000) | — | 847 0 0 | — | — | — | — |
| ,, 29 | East Pool (128) | — | 835 0 7 | — | — | 5 0 0 | 640 0 0 |
| ,, 30 | Rosewarne Consols (4,026) | 1,298 10 4 | — | 0 6 6 | 1,308 9 0 | — | — |
| ,, 30 | Pendeen Consols (5,000) | 521 19 5 | — | — | — | — | — |
| ,, 30 | New Seton (400) | — | — | 2 0 0 | 800 0 0 | — | — |
| July 1 | Wheal Emma (4,000) | — | 560 14 10 | — | — | — | — |
| ,, 1 | Wheal Crofty (6,000) | — | — | 0 7 0 | 2,100 0 0 | — | — |
| ,, 2 | Wheal Basset & Grylls (1,000) | — | 1,041 13 6 | — | — | 0 10 0 | 500 0 0 |
| ,, 6 | Nangiles (1,024) | — | — | 1 0 0 | 1,024 0 0 | — | — |
| ,, 6 | West Great Work (4,216) | — | — | 0 2 0 | 421 12 0 | — | — |
| ,, 6 | South Frances (496) | — | 1,324 13 4 | — | — | 1 0 0 | 496 0 0 |
| ,, 6 | Leeds & St. Aubyn (1,019) | — | 159 3 2 | — | — | — | — |
| ,, 7 | Marke Valley (9,000) | — | 2,060 4 9 | — | — | 0 1 0 | 450 0 0 |
| ,, 7 | Wheal Kitty (Lelant) (1,024) | — | 221 4 3 | — | — | — | — |
| ,, 7 | East Treskerby (1,024) | 447 2 10 | — | 0 12 6 | 640 0 0 | — | — |
| ,, 8 | East Caradon (6,144) | — | 5,459 12 2 | — | — | 0 12 6 | 3,840 0 0 |
| ,, 8 | Stray Park (920) | 1,072 12 4 | — | 1 3 6 | 1,081 0 0 | — | — |
| ,, 8 | Carn Camborne (6,000) | — | 20 13 0 | 0 2 6 | 750 0 0 | — | — |
| ,, 8 | West Rose Down (1,000) | — | 50 14 9 | 1 0 0 | 1,000 0 0 | — | — |
| ,, 8 | Wheal Damsel (512) | 342 14 11 | — | 1 10 0 | 768 0 0 | — | — |
| ,, 10 | Frank Mills (5,000) | — | 708 6 9 | — | — | — | — |
| ,, 13 | New Treleigh (6,000) | 2,185 10 11 | — | 0 5 0 | 1,500 0 0 | — | — |
| ,, 14 | Bedford United (4,000) | — | 338 13 6 | — | — | 0 1 6 | 300 0 0 |
| ,, 14 | North Roskear (700) | 650 14 10 | — | 1 0 0 | 700 0 0 | — | — |
| ,, 14 | Roskearnoweth (700) | — | 433 18 0 | — | — | — | — |
| ,, 15 | Wheal Ludcott & Wrey Consols (4,800) | — | 423 8 6 | — | — | — | — |
| ,, 15 | Trumpet United (4,000) | 526 16 9 | — | 0 2 6 | 500 0 0 | — | — |
| ,, 16 | Wheal Edward (4,096) | 290 0 0 | — | 0 3 0 | 614 8 0 | — | — |
| ,, 20 | West Damsel (256) | — | 652 0 0 | — | — | 1 0 0 | 256 0 0 |
| ,, 20 | Wheal Emily Henrietta (1,024) | 69 0 0 | — | 0 10 0 | 512 0 0 | — | — |
| ,, 21 | Wheal Crofty (6,000) | — | — | 0 5 0 | 1,500 0 0 | — | — |
| ,, 21 | Wheal Buller (256) | — | 203 11 8 | — | — | — | — |
| ,, 21 | New Trevenen (960) | — | — | 0 7 0 | 336 0 0 | — | — |
| ,, 22 | Wheal Sidney (4,096) | 116 7 2 | — | — | — | — | — |
| ,, 22 | North Rosewarne (1,024) | 207 10 3 | — | 1 0 0 | 1,024 0 0 | — | — |
| | **WELSH & OTHER MINES.** | | | | | | |
| June 19 | Cwm Erfin (867) | — | — | — | — | 0 15 0 | 650 5 0 |
| ,, 19 | Dale Mine (30,000) | — | 349 0 7 | — | — | — | — |
| July 22 | Bryn Gwiog (500) | — | 76 5 9 | 2 0 0 | 1,000 0 0 | — | — |
| | **FOREIGN MINE.** | | | | | | |
| June 25 | General Mining Association (25,000) | — | 20,802 0 0 | — | — | 0 10 0 | 12,500 0 0 |

# Copper Ores.

**Sampled June 10, and sold at Tabb's Hotel, Redruth, June 25.**

| Mines. | Tons. | Purchasers. | Price. £ | s. | d. |
|---|---|---|---|---|---|
| South Caradon | 86 | 6, 11 | £5 | 4 | 0 |
| | 83 | 1, 7 | 8 | 1 | 6 |
| | 82 | 2 | 5 | 3 | 6 |
| | 73 | 1, 6 | 9 | 1 | 6 |
| | 55 | 1, 5 | 14 | 9 | 6 |
| | 53 | 1, 5, 6 | 19 | 0 | 6 |
| | 49 | 6 | 6 | 16 | 0 |
| | 25 | 7 | 6 | 1 | 6 |
| Great Wheal Busy | 91 | 14 | 3 | 0 | 0 |
| | 71 | 7, 9 | 2 | 4 | 0 |
| | 50 | 13 | 3 | 5 | 6 |
| | 48 | 11 | 3 | 12 | 6 |
| | 47 | 8 | 2 | 2 | 0 |
| | 36 | 7, 8, 11 | 3 | 3 | 6 |
| | 35 | 14 | 2 | 4 | 6 |
| | 20 | 5 | 1 | 3 | 0 |
| | 2 | 1 | 37 | 0 | 0 |
| West Damsel | 91 | 7 | 3 | 4 | 6 |
| | 71 | 9, 13 | 3 | 18 | 0 |
| | 67 | 2, 7 | 3 | 17 | 0 |
| | 63 | 7 | 4 | 11 | 0 |
| | 53 | 7 | 3 | 9 | 6 |
| | 45 | 13 | 4 | 0 | 0 |
| Fowey Consols | 69 | 1, 5 | 5 | 6 | 6 |
| | 66 | 1, 5 | 6 | 6 | 6 |
| | 62 | 6 | 5 | 1 | 6 |
| | 58 | 1 | 6 | 10 | 6 |
| | 45 | 5 | 5 | 6 | 0 |
| Tywarnhaile | 82 | 12 | 4 | 1 | 6 |
| Tywarnhaile | 65 | 7, 9 | £7 | 11 | 6 |
| | 53 | 12 | 2 | 0 | 6 |
| | 50 | 6 | 4 | 8 | 0 |
| Clifford Amalgamated | 73 | 9 | 5 | 3 | 6 |
| | 52 | 8 | 4 | 15 | 0 |
| | 30 | 5, 6 | 4 | 4 | 0 |
| | 20 | 3 | 0 | 11 | 0 |
| | 16 | 12 | 3 | 19 | 6 |
| | 12 | 3 | 13 | 2 | 6 |
| Craddock Moor | 65 | 6 | 5 | 10 | 6 |
| | 63 | 2, 6, 9 | 5 | 11 | 6 |
| | 40 | 5 | 6 | 17 | 0 |
| | 17 | 8 | 2 | 18 | 6 |
| New Treleigh | 50 | 10 | 3 | 9 | 6 |
| | 44 | 7 | 3 | 7 | 0 |
| Great Brigan | 48 | 9, 11 | 6 | 3 | 0 |
| | 34 | 7, 13 | 5 | 2 | 6 |
| | 10 | 2 | 2 | 14 | 0 |
| Bampfylde | 63 | 1, 5 | 13 | 4 | 0 |
| Great North Downs | 57 | 14 | 4 | 11 | 6 |
| North Grambler | 32 | 14 | 5 | 14 | 6 |
| Boscawen | 32 | 14 | 4 | 6 | 6 |
| Falmouth & Sperries | 26 | 1, 5 | 3 | 8 | 6 |
| Wheal Vyvyan | 12 | 5 | 1 | 7 | 0 |
| | 10 | 5 | 5 | 1 | 0 |
| Grambler & St. Aubyn | 11 | 14 | 4 | 17 | 0 |
| Creegbrawse | 9 | 5 | 4 | 7 | 0 |
| Wheal Jane | 6 | 8 | 2 | 9 | 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. £ | s. | d. |
|---|---|---|---|---|
| South Caradon | 505 | £4,488 | 11 | 6 |
| Great Wheal Busy | 400 | 1,154 | 16 | 6 |
| West Damsel | 380 | 1,446 | 18 | 0 |
| Fowey Consols | 300 | 1,716 | 9 | 6 |
| Tywarnhaile | 250 | 1,153 | 17 | 0 |
| Clifford Amalgamated | 203 | 982 | 17 | 6 |
| Craddock Moor | 185 | 1,034 | 1 | 6 |
| New Treleigh Consols | 94 | 321 | 3 | 0 |
| Great Brigan | 92 | 496 | 9 | 0 |
| Bampfylde | 63 | £831 | 12 | 0 |
| Great North Downs | 57 | 260 | 15 | 6 |
| North Grambler | 32 | 183 | 4 | 0 |
| Coscawen | 32 | 138 | 8 | 0 |
| Falmouth and Sperries | 26 | 89 | 1 | 0 |
| Wheal Vyvyan | 22 | 64 | 14 | 0 |
| Grambler and St. Aubyn | 11 | 53 | 7 | 0 |
| Creegbrawse | 9 | 39 | 3 | 0 |
| Wheal Ellen | 6 | 14 | 14 | 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. £ | s. | d. |
|---|---|---|---|---|
| 1 Vivian and Sons | 295 1-6 | £2,705 | 14 | 8 |
| 2 Freeman and Co. | 146½ | 697 | 8 | 0 |
| 3 Grenfell and Sons | 32 | 169 | 10 | 0 |
| 4 Crown Copper Co. | — | — | | |
| 5 Sims, Willyams & Co. | 308 1-6 | 2,291 | 5 | 8 |
| 6 Williams, Foster & Co. | 343½ | 2,232 | 7 | 11 |
| 7 Mason and Elkington | 453 | 2,007 | 18 | 6 |
| 8 Bankart and Sons | 134 | 448 | 4 | 6 |
| 9 Copper Miners' Co. | 221½ | £1,105 | 3 | 9 |
| 10 Charles Lambert | 50 | 173 | 15 | 0 |
| 11 Newton, Keates & Co. | 126½ | 580 | 14 | 0 |
| 12 Sweetland, Tuttle & Co. | 151 | 505 | 1 | 6 |
| 13 Neath Copper Co. | 147½ | 569 | 6 | 6 |
| 14 Penclawdd Copper Co. | 258 | 986 | 12 | 0 |
| Total | 2,667 | £14,472 | 2 | 0 |

Average Produce, 7½.
Quantity of Fine Copper, 192 tons 16 cwts.

Average Standard ................£113 2 0
Average Price per ton ............ 5 9 0

# Copper Ores.

**Sampled June 17, and sold at Tyack's Hotel, Camborne, July 2.**

| Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|
| Clifford Amalgamated | 102 | 3 | £7 8 0 |
| | 101 | 9 | 7 12 0 |
| | 100 | 10, 12 | 3 14 0 |
| | 98 | 7 | 4 2 6 |
| | 90 | 7, 9 | 7 13 0 |
| | 84 | 9 | 3 13 6 |
| | 80 | 5 | 7 15 0 |
| | 63 | 11 | 4 11 6 |
| | 62 | 1 | 7 7 0 |
| | 58 | 11 | 4 9 0 |
| | 35 | 7 | 2 11 0 |
| | 27 | 7 | 4 7 0 |
| West Seton ............ | 83 | 12 | 2 13 6 |
| | 74 | 1 | 6 5 6 |
| | 68 | 7 | 2 8 0 |
| | 66 | 6 | 6 18 6 |
| | 63 | 3 | 3 15 6 |
| | 62 | 2 | 5 18 0 |
| | 52 | 3 | 6 6 6 |
| | 35 | 1, 6 | 8 10 6 |
| South Tolgus ......... | 81 | 3, 10 | 4 5 0 |
| | 52 | 14 | 4 10 0 |
| | 51 | 3 | 7 10 6 |
| | 44 | 3 | 8 5 6 |
| | 42 | 7 | 7 1 0 |
| East Pool ............... | 85 | 8 | 4 6 6 |
| | 83 | 8, 14 | 4 6 6 |
| | 70 | 12 | 3 11 6 |
| Wheal Seton ............ | 43 | 7, 13 | 5 19 0 |
| (Pendarves) | 62 | 7 | 5 17 0 |
| Wheal Seton ............ | 50 | 2, 6 | £6 13 0 |
| (Pendarves) | 48 | 2, 6, 9, 14 | 5 4 6 |
| | 14 | 9 | 1 10 0 |
| | 13 | 7 | 15 0 0 |
| | 5 | 1 | 2 10 6 |
| North Roskear ......... | 40 | 5, 10, 12 | 3 13 6 |
| | 43 | 5, 7 | 2 11 6 |
| | 42 | 1, 6 | 6 14 0 |
| | 36 | 1, 3, 13 | 7 13 6 |
| Tolcarne.................. | 55 | 8 | 2 10 0 |
| | 46 | 8 | 3 6 0 |
| | 29 | 1 | 8 7 6 |
| | 28 | 5, 9 | 2 4 0 |
| Wheal Basset ......... | 44 | 5 | 5 19 0 |
| | 43 | 1, 13 | 4 9 0 |
| | 40 | 9 | 4 3 0 |
| North Crofty............ | 92 | 5 | 1 10 0 |
| | 30 | 6, 13 | 5 17 0 |
| South Frances ......... | 61 | 6 | 4 15 0 |
| | 40 | 1, 13 | 7 18 6 |
| | 20 | 7 | 5 1 0 |
| East Basset ............ | 57 | 14 | 7 9 6 |
| | 31 | 14 | 20 10 6 |
| | 16 | 3 | 14 11 6 |
| West Stray Park ...... | 51 | 2, 7, 9, 13 | 4 16 6 |
| | 27 | 9 | 8 0 0 |
| Carn Camborne ...... | 37 | 12 | 1 15 6 |
| | 7 | 13 | 6 7 0 |
| South Basset............ | 22 | 10 | 2 3 6 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. |
|---|---|---|
| Clifford Amalgamated...... | 901 | £5,126 14 0 |
| West Seton...................... | 503 | 2,537 10 6 |
| South Tolgus.................. | 270 | 1,622 4 6 |
| East Pool ..................... | 238 | 976 17 0 |
| Wheal Seton .................. | 235 | 1,430 9 6 |
| North Roskear ............... | 161 | 815 8 6 |
| Tolcarne ..................... | 156 | 593 15 6 |
| Wheal Basset .................. | 127 | £619 3 0 |
| North Crofty .................. | 122 | 313 10 0 |
| South Frances ............... | 121 | 707 15 0 |
| East Basset..................... | 104 | 1,295 11 0 |
| West Stray Park ............ | 78 | 462 1 6 |
| Carn Camborne............... | 44 | 110 2 6 |
| South Basset .................. | 22 | 47 17 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount |
|---|---|---|
| 1 Vivian and Sons ......... | 262 | £1,811 14 3 |
| 2 Freeman and Co.......... | 111¾ | 656 5 5 |
| 3 Grenfell and Sons ...... | 380½ | 2,566 16 6 |
| 4 Crown Copper Co. ...... | — | —— |
| 5 Sims, Willyams & Co. | 264 5-6 | 1,154 19 3 |
| 6 Williams, Foster & Co. | 217½ | 1,353 7 9 |
| 7 Mason and Elkington ... | 466¾ | 2,322 2 7 |
| 8 Bankart and Sons ...... | 227½ | 836 8 3 |
| 9 Copper Miners' Co. ...... | 349½ | £1,978 11 5 |
| 10 Charles Lambert ......... | 122 5-6 | 453 19 6 |
| 11 Newton, Keates & Co. ... | 121 | 546 6 6 |
| 12 Sweetland, Tuttle & Co. | 253½ | 771 19 0 |
| 13 Neath Copper Co. ...... | 109¾ | 667 18 4 |
| 14 Penclawdd Copper Co. | 193½ | 1,538 10 9 |
| Total ............... | 3,084 | £16,658 19 6 |

Average Produce, 7.
Quantity of Fine Copper, 215 tons 6 cwts.

Average Standard ..................£116 15 0
Average Price per ton ............ 5 8 0

# Copper Ores.

**Sampled June 24, and sold at Tabb's Hotel, Redruth, July 9.**

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| East Carn Brea......... | 76 | 5 | £6 | 6 | 6 |
| | 72 | 11 | 5 | 14 | 0 |
| | 57 | 5, 6, 13 | 6 | 15 | 0 |
| | 41 | 2 | 6 | 5 | 6 |
| | 40 | 5 | 5 | 15 | 0 |
| | 39 | 5 | 5 | 3 | 6 |
| | 30 | 5 | 4 | 19 | 6 |
| | 17 | 5 | 5 | 6 | 0 |
| | 16 | 2 | 3 | 2 | 6 |
| West Basset ............ | 78 | 9 | 4 | 11 | 6 |
| | 70 | 10 | 4 | 13 | 6 |
| | 58 | 7 | 5 | 17 | 0 |
| | 48 | 7, 11 | 4 | 3 | 0 |
| | 44 | 10, 13 | 4 | 7 | 6 |
| | 40 | 3 | 6 | 17 | 6 |
| | 33 | 3 | 4 | 11 | 0 |
| Prosper United......... | 87 | 12 | 4 | 11 | 0 |
| | 51 | 14 | 1 | 10 | 0 |
| | 42 | 12 | 4 | 12 | 0 |
| | 24 | 8 | 5 | 10 | 6 |
| Par Consols ............ | 65 | 6, 9 | 6 | 15 | 6 |
| | 59 | 7 | 7 | 4 | 6 |
| | 58 | 7 | 7 | 10 | 6 |
| Wheal Margery ...... | 49 | 1, 6 | 6 | 12 | 6 |
| | 48 | 1, 12 | 2 | 2 | 6 |
| | 45 | 6 | 2 | 3 | 6 |
| | 6 | 1 | 4 | 13 | 6 |

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| East Rosewarne ...... | 30 | 3 | £7 | 5 | 6 |
| | 29 | 1 | 12 | 4 | 6 |
| | 25 | 3 | 8 | 17 | 6 |
| | 23 | 12 | 2 | 17 | 0 |
| | 22 | 11 | 6 | 14 | 0 |
| Copper Hill ............ | 45 | 8 | 2 | 7 | 6 |
| | 34 | 3 | 8 | 9 | 0 |
| Tolvadden ............... | 26 | 1 | 4 | 12 | 6 |
| | 25 | 1 | 3 | 6 | 6 |
| | 24 | 8 | 7 | 16 | 6 |
| Charlotte United ...... | 44 | 8 | 5 | 18 | 6 |
| | 20 | 6 | 8 | 10 | 6 |
| South Crenver ......... | 30 | 7 | 2 | 1 | 0 |
| | 20 | 2 | 4 | 19 | 6 |
| | 4 | 1 | 10 | 5 | 6 |
| North Basset............ | 28 | 13 | 3 | 17 | 6 |
| | 22 | 1, 7 | 2 | 0 | 6 |
| Wheal Buller............ | 42 | 7 | 3 | 3 | 6 |
| | 4 | 7 | 12 | 14 | 0 |
| | 1 | 5 | 36 | 8 | 0 |
| South Carn Brea ...... | 15 | 5 | 3 | 8 | 0 |
| | 1 | 1 | 43 | 0 | 0 |
| Wheal Agar ............ | 14 | 9 | 5 | 11 | 0 |
| St. Ives Consols ...... | 14 | 1 | 10 | 8 | 6 |
| West Trevelyan ...... | 13 | 1 | 5 | 13 | 6 |
| Wheal Florence ...... | 12 | 3 | 7 | 16 | 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| East Carn Brea................ | 388 | £2,254 | 6 | 0 |
| West Basset .................. | 371 | 1,840 | 5 | 0 |
| Prosper United ............... | 204 | 798 | 3 | 0 |
| Par Consols .................. | 182 | 1,303 | 2 | 0 |
| Wheal Margery................ | 148 | 552 | 11 | 0 |
| East Rosewarne ............ | 129 | 1,007 | 12 | 0 |
| Copper Hill ................. | 79 | 394 | 3 | 6 |
| Tolvadden ..................... | 75 | 391 | 3 | 6 |
| Charlotte United ............ | 64 | 431 | 4 | 0 |
| South Crenver ............... | 54 | £202 | 2 | 0 |
| North Basset .................. | 50 | 153 | 1 | 0 |
| Wheal Buller.................. | 47 | 220 | 11 | 0 |
| South Carn Brea ............ | 16 | 94 | 0 | 0 |
| Wheal Agar .................. | 14 | 77 | 14 | 0 |
| St. Ives Consols ............ | 14 | 145 | 19 | 0 |
| West Trevelyan ........... | 13 | 73 | 15 | 6 |
| Wheal Florence ........... | 12 | 93 | 12 | 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| 1 Vivian and Sons ............ | 177½ | £1,125 | 7 | 3 |
| 2 Freeman and Co. ......... | 77 | 406 | 15 | 6 |
| 3 Grenfell and Sons ......... | 174 | 1,246 | 3 | 6 |
| 4 Crown Copper Co. ......... | — | —— | | |
| 5 Sims, Willyams & Co. ... | 237 | 1,367 | 10 | 6 |
| 6 Williams, Foster & Co. ... | 141 | 779 | 2 | 6 |
| 7 Mason and Elkington ... | 286 | 1,569 | 11 | 0 |
| 8 Bankart and Sons ... ..... | 137 | 687 | 19 | 6 |
| 9 Copper Miners' Co. ... | 114½ | 654 | 14 | 9 |
| 10 Charles Lambert......... | 92 | 423 | 10 | 0 |
| 11 Newton, Keates & Co. | 118 | 657 | 8 | 0 |
| 12 Sweetland, Tuttle & Co. | 176 | 705 | 12 | 0 |
| 13 Neath Copper Co. ...... | 69 | 333 | 0 | 0 |
| 14 Penclawdd Copper Co. | 51 | 76 | 10 | 0 |
| Total............... | 1,860 | £10,033 | 4 | 6 |

Average Produce, 6⅞.
Quantity of Fine Copper, 128 tons 0 cwts.

Average Standard .................. £118 7 0
Average Price per ton ........... 5 8 0

No Sale on July 16th.

# Copper Ores.

**Sampled July 8, and sold at the Royal Hotel, Truro, July 23.**

| Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|
| Devon Great Consols | 134 | 8 | £4 14 0 |
| | 133 | 6 | 5 17 0 |
| | 129 | 9 | 5 13 6 |
| | 128 | 5 | 6 1 0 |
| | 124 | 7 | 5 4 0 |
| | 123 | 3 | 5 16 0 |
| | 122 | 5 | 5 17 0 |
| | 120 | 12 | 4 10 0 |
| | 116 | 5, 6 | 5 16 6 |
| | 115 | 11 | 5 2 0 |
| | 110 | 3, 9 | 4 2 0 |
| | 107 | 5 | 4 2 0 |
| | 102 | 9 | 4 13 6 |
| | 94 | 6 | 11 2 6 |
| | 92 | 6 | 6 2 0 |
| | 91 | 5 | 2 6 6 |
| | 82 | 6 | 5 1 6 |
| | 49 | 6 | 10 13 6 |
| | 47 | 6 | 5 15 0 |
| | 43 | 5 | 2 6 0 |
| | 42 | 6 | 4 2 6 |
| | 33 | 3 | 6 14 6 |
| | 21 | 5 | 3 5 0 |
| East Caradon | 96 | 3, 9 | 4 15 6 |
| | 89 | 10 | 4 12 6 |
| | 77 | 3 | 5 7 6 |
| | 69 | 1, 3, 6 | 6 12 6 |
| | 64 | 12 | 4 15 0 |
| | 55 | 6 | 7 12 6 |
| | 53 | 1 | 7 14 6 |
| Phœnix Mines | 122 | 8 | 2 7 0 |
| | 105 | 7, 8 | 1 16 6 |
| | 98 | 8 | 4 1 6 |
| | 64 | 2, 8 | 2 11 0 |
| | 56 | 7 | 4 0 0 |
| | 21 | 5 | 10 13 0 |
| New Wheal Martha | 100 | 1, 5 | 3 0 6 |
| | 91 | 1, 5 | 2 19 6 |
| | 76 | 1, 5 | 2 17 6 |
| | 72 | 1, 5 | 2 16 6 |
| | 50 | 1, 5 | 1 19 6 |
| | 37 | 1, 5 | 5 12 6 |
| | 36 | 1, 5 | 1 11 6 |
| Marke Valley | 84 | 6 | 3 4 6 |
| Marke Valley | 83 | 6 | £3 13 6 |
| | 82 | 12 | 3 9 6 |
| | 75 | 9 | 3 7 0 |
| | 45 | 10 | 1 11 6 |
| | 41 | 1 | 1 12 0 |
| Hingston Down | 83 | 9 | 2 10 6 |
| | 76 | 9 | 3 10 0 |
| | 75 | 7 | 2 7 0 |
| | 70 | 7, 8 | 2 7 0 |
| | 69 | 3 | 2 13 6 |
| | 28 | 3 | 8 1 6 |
| Wheal Edward | 53 | 2 | 4 9 6 |
| | 50 | 2 | 4 9 6 |
| | 43 | 7 | 5 3 0 |
| | 40 | 10, 12 | 1 7 0 |
| | 29 | 10, 12 | 2 2 6 |
| | 19 | 7 | 7 0 0 |
| East Russell | 70 | 10 | 4 8 0 |
| | 50 | 10 | 2 14 0 |
| | 41 | 7, 10 | 4 14 0 |
| | 40 | 10 | 2 18 0 |
| | 22 | 7 | 8 16 6 |
| Bedford United | 106 | 14 | 4 11 0 |
| | 95 | 7 | 3 12 6 |
| Kelly Bray | 57 | 6, 13 | 6 19 6 |
| | 44 | 3 | 2 6 6 |
| | 40 | 3, 6, 13 | 7 2 6 |
| | 36 | 3 | 5 14 0 |
| Holmbush | 53 | 13 | 3 1 0 |
| | 52 | 7 | 10 10 6 |
| | 48 | 9 | 9 10 0 |
| Wheal Friendship | 77 | 10 | 2 11 6 |
| | 54 | 5 | 8 17 0 |
| Wheal Emma | 55 | 5 | 1 15 6 |
| | 41 | 8 | 3 19 0 |
| | 24 | 2 | 6 19 0 |
| Brookwood | 60 | 13 | 3 3 0 |
| | 24 | 2 | 5 14 0 |
| | 16 | 8 | 1 2 0 |
| Lady Bertha | 64 | 7 | 2 10 0 |
| Calstock Consols | 58 | 3 | 2 2 6 |
| Fursdon | 25 | 12 | 3 15 6 |
| Crocker's Ore | 5 | 5 | 10 2 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. |
|---|---|---|
| Devon Great Consols | 2,157 | £11,745 6 0 |
| East Caradon | 503 | 2,873 16 6 |
| Phœnix Mines | 466 | 1,488 10 6 |
| New Wheal Martha | 462 | 1,358 14 0 |
| Marke Valley | 410 | 1,248 12 0 |
| Hingston Down | 401 | 1,227 0 0 |
| Wheal Edward | 234 | 931 0 0 |
| East Russell | 233 | 945 17 0 |
| Bedford United | 201 | 826 13 6 |
| Kelly Bray | 177 | £900 1 6 |
| Holmbush | 153 | 1,164 19 0 |
| Wheal Friendship | 131 | 676 3 6 |
| Wheal Emma | 120 | 426 7 6 |
| Brookwood | 100 | 343 8 0 |
| Lady Bertha | 64 | 160 0 0 |
| Calstock Consols | 58 | 123 5 0 |
| Fursdon | 25 | 94 7 6 |
| Crocker's Ore | 5 | 50 10 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. |
|---|---|---|
| 1 Vivian and Sons | 348 | £1,306 15 0 |
| 2 Freeman and Co. | 183 | 846 2 6 |
| 3 Grenfell and Sons | 607½ | 2,892 14 0 |
| 4 Crown Copper Co. | — | —— |
| 5 Sims, Willyams & Co. | 936 | 4,172 8 0 |
| 6 Williams, Foster & Co. | 883 5-6 | 5,547 0 9 |
| 7 Mason and Elkington | 658 | 2,919 14 9 |
| 8 Bankart and Sons | 530½ | 1,755 1 3 |
| 9 Copper Miners' Co. | 616 | £2,846 9 0 |
| 10 Charles Lambert | 426 | 1,393 18 9 |
| 11 Newton, Keates & Co. | 115 | 586 10 0 |
| 12 Sweetland, Tuttle & Co. | 325½ | 1,281 2 9 |
| 13 Neath Copper Co. | 154 5-6 | 644 8 9 |
| 14 Penclawdd Co. | 106 | 482 6 0 |
| Total | 5,890 | £26,674 11 6 |

Average Produce, 6.
Quantity of Fine Copper, 350 tons 11 cwts.

Average standard ..................£122 6 0
Average Price per ton ............ 4 10 6

# Copper Ores.

**Sampled June 17, and sold at Swansea July 7.**

| Mines. | Tons. | Pro-duce. | Pur-chasers. | Price. | | |
|---|---|---|---|---|---|---|
| Chili | 69 | 24⅞ | 7 | £20 | 16 | 0 |
| | 68 | 24⅝ | 1 | 20 | 10 | 6 |
| | 67 | 24⅜ | 13 | 20 | 9 | 0 |
| | 66 | 24½ | 11 | 20 | 12 | 6 |
| | 72 | 18⅝ | 9 | 15 | 15 | 6 |
| | 68 | 19⅜ | 9 | 16 | 7 | 6 |
| | 71 | 20 | 16 | 25 | 14 | 6 |
| | 70 | 19⅝ | 14 | 17 | 0 | 0 |
| | 55 | 27⅞ | 7 | 23 | 14 | 0 |
| Cuba | 100 | 11⅝ | 15 | 8 | 17 | 6 |
| | 95 | 11⅝ | 7 | 8 | 15 | 6 |
| | 92 | 11⅝ | 1 | 8 | 17 | 0 |
| | 91 | 11⅜ | 3 | 8 | 15 | 0 |
| | 85 | 11 | 11 | 8 | 13 | 6 |
| | 81 | 11⅜ | 11 | 9 | 0 | 0 |
| Cuba | 58 | 20⅞ | 3 | £17 | 12 | 6 |
| | 8 | 62 | 5 | 50 | 7 | 0 |
| Berehaven | 80 | 10¼ | 10 | 8 | 8 | 0 |
| | 68 | 10⅜ | 13 | 8 | 9 | 6 |
| | 127 | 10⅝ | 2 | 8 | 16 | 0 |
| | 122 | 10⅝ | 7, 15 | 8 | 12 | 0 |
| | 85 | 10½ | 2, 7 | 8 | 11 | 6 |
| Cobre | 92 | 12⅝ | 6 | 10 | 16 | 0 |
| | 91 | 12½ | 3 | 10 | 14 | 0 |
| | 84 | 12⅜ | 5, 6 | 10 | 12 | 0 |
| Seville | 60 | 8⅝ | 2 | 6 | 15 | 0 |
| | 13 | 4¼ | 10 | 3 | 7 | 6 |
| | 14 | 3⅜ | 2 | 2 | 15 | 6 |
| Holyford | 7 | 21¾ | 2 | 17 | 15 | 0 |
| Australian | 1 | 25⅞ | 5 | 20 | 14 | 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Chili | 606 | £12,131 | 11 | 6 |
| Cuba | 610 | 6,223 | 0 | 0 |
| Berehaven | 482 | 4,143 | 19 | 6 |
| Cobre | 267 | 2,857 | 14 | 0 |
| Seville | 87 | £487 | 14 | 6 |
| Holyford | 7 | 124 | 5 | 0 |
| Australian | 1 | 20 | 14 | 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| 1 Copper Miners' Co. | 160 | £2,209 | 18 | 0 |
| 2 Freeman and Co. | 250½ | 2,060 | 2 | 9 |
| 3 Grenfell and Sons | 240 | 2,792 | 4 | 0 |
| 4 Crown Copper Co. | — | — | | |
| 5 Sims, Willyams, Nevill & Co. | 51 | 868 | 14 | 0 |
| 6 Vivians and Sons | 134 | 1,438 | 16 | 0 |
| 7 Williams, Foster & Co. | 322½ | 4,461 | 7 | 3 |
| 8 British and For. Copper Co. | — | — | | |
| 9 Mason and Elkington | 140 | 2,249 | 6 | 0 |
| 10 Bankart and Sons | 93 | £715 | 17 | 6 |
| 11 Charles Lambert | 232 | 2,827 | 12 | 6 |
| 12 Ravenhead Copper Co. | — | — | | |
| 13 Sweetland, Tuttle & Co. | 135 | 1,946 | 9 | 0 |
| 14 Jennings & Co. | 70 | 1,190 | 0 | 0 |
| 15 Neath Copper Co. | 161 | 1,412 | 2 | 0 |
| 16 Penclawdd Copper Co. | 71 | 1,826 | 9 | 6 |
| Total | 2,060 | £25,938 | 18 | 6 |

# Blende Sales.

| Date. | Mines. | Tons. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|
| June 29. | Great Retallack | 98 | 2 | 11 | 0 | Vivian & Sons | 249 | 18 | 0 |
| July 3. | Minera | 25 | 3 | 10 | 0 | ditto | 410 | 9 | 0 |
| | " | 50 | 4 | 4 | 0 | ditto | | | |
| | " | 21 | 1 | 19 | 0 | ditto | | | |
| | " | 16 | 4 | 10 | 0 | ditto | | | |

# Sundry Copper Ore Sales.

| Date. | Mines | Tons. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|
| June 17. | Laxey Mines | 119¾ | 4 | 14 | 0 | J. Radley, jun. | 561 | 13 | 0 |
| " 22. | West Canada (ex Agia Sofia) | 55 | 17 | 4 | 0 | Bibby Sons & Co. | 3,869 | 5 | 0 |
| | " " | 55 | 17 | 18 | 6 | ditto | | | |
| | " (ex St. Andrew) | 55 | 17 | 14 | 6 | ditto | | | |
| | " " | 55 | 17 | 10 | 0 | ditto | | | |
| | Knockmahon (ex West Docks) | 65 | 9 | 9 | 0 | Newton, Keates & Co. | 2,620 | 12 | 6 |
| | " " | 65 | 9 | 11 | 0 | ditto | | | |
| | " (ex Brothers) | 75 | 9 | 4 | 6 | St. Helen's Co. | | | |
| | " " | 75 | 9 | 5 | 0 | Newton, Keates & Co. | | | |
| July 21. | Lot 1 (Pary's Mines) | 380 | 5 | 17 | 6 | Mona Co. | 2,903 | 10 | 0 |
| | 2 " | 110 | 3 | 1 | 0 | ditto | | | |
| | 3 " | 110 | 3 | 1 | 0 | C. Lambert | | | |

# Copper Ores.

Sampled June 10, and sold at Swansea, June 30.

| Mines. | Tons. | Produce. | Purchasers. | Price. | | |
|---|---|---|---|---|---|---|
| Berehaven ...... | 129 | 11 | 1, 7 | £8 | 18 | 6 |
| | 120 | 11¼ | 7 | 9 | 2 | 0 |
| | 51 | 11⅛ | 9 | 9 | 6 | 0 |
| | 104 | 10⅝ | 7 | 8 | 12 | 6 |
| | 80 | 10⅝ | 1, 3 | 8 | 12 | 0 |
| | 47 | 11½ | 16 | 9 | 3 | 6 |
| | 110 | 10½ | 3 | 8 | 5 | 6 |
| | 92 | 10¼ | 13 | 8 | 7 | 0 |
| Cobre ............... | 90 | 12⅝ | 12 | 10 | 2 | 6 |
| | 83 | 12¾ | 11, 12 | 10 | 2 | 6 |
| | 79 | 12½ | 11, 12 | 10 | 2 | 6 |
| | 88 | 12⅝ | 1 | 10 | 0 | 6 |
| | 86 | 12½ | 11 | 10 | 2 | 6 |
| | 77 | 12¼ | 11 | 10 | 2 | 6 |
| | 71 | 12⅝ | 11 | 10 | 2 | 6 |
| | 53 | 30⅞ | 3 | 25 | 0 | 0 |
| | 49 | 30⅝ | 7 | 24 | 17 | 0 |
| | 9 | 16⅝ | 7 | 13 | 14 | 0 |
| Knockmahon...... | 87 | 10⅝ | 7 | 8 | 11 | 0 |
| | 63 | 5⅜ | 5, 7 | 4 | 0 | 6 |
| | 63 | 5½ | 2 | 4 | 1 | 0 |
| | 61 | 10½ | 2, 7 | 8 | 15 | 6 |
| | 60 | 10⅜ | 13 | 8 | 11 | 6 |
| Knockmahon...... | 98 | 11½ | 2, 7 | £8 | 16 | 0 |
| Cape Copper ...... | 42 | 20½ | 11 | 17 | 3 | 6 |
| | 34 | 20⅝ | 11 | 17 | 7 | 6 |
| | 58 | 39 | 11 | 33 | 3 | 0 |
| | 35 | 29⅝ | 3 | 25 | 6 | 9 |
| | 11 | 26 | 10, 16 | 22 | 3 | 0 |
| | 35 | 32 | 3 | 27 | 5 | 0 |
| | 8 | 27 | 3 | 23 | 0 | 6 |
| Laxey ............... | 131 | 6⅜ | 7 | 5 | 0 | 6 |
| Connorree ......... | 79 | 4 | 2 | 2 | 16 | 0 |
| | 42 | 4⅜ | 2, 6 | 2 | 18 | 0 |
| | 8 | 3⅝ | 14 | 2 | 1 | 6 |
| Sestri ............... | 43 | 9½ | 15 | 7 | 14 | 6 |
| | 42 | 16⅝ | 15, 16 | 14 | 0 | 6 |
| | 36 | 12 | 16 | 9 | 17 | 0 |
| | 6 | 11 | 12 | 8 | 19 | 0 |
| Genoa ............... | 75 | 6⅜ | 14 | 5 | 10 | 0 |
| | 47 | 6½ | 14 | 5 | 0 | 6 |
| Kanmantoo ...... | 25 | 53½ | 5, 14 | 45 | 10 | 6 |
| | 18 | 52 | 14 | 44 | 4 | 6 |
| Lisbon ........... | 60 | 26⅜ | 2, 15 | 21 | 2 | 6 |
| | 56 | 26⅝ | 1 | 20 | 16 | 6 |
| | 6 | 26⅝ | 10, 16 | 21 | 2 | 6 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Berehaven ............... | 733 | £6,412 | 6 | 0 |
| Cobre......................... | 685 | 8,468 | 18 | 0 |
| Knockmahon ............ | 432 | 3,164 | 15 | 0 |
| Cape Copper ............ | 223 | 5,501 | 19 | 6 |
| Laxey ...................... | 131 | 658 | 5 | 6 |
| Connorree .................. | 129 | £359 | 12 | 0 |
| Sestri.......................... | 127 | 1,329 | 7 | 6 |
| Genoa ......................... | 122 | 648 | 13 | 6 |
| Kanmantoo .................. | 43 | 1,934 | 3 | 6 |
| Lisbon ........................ | 122 | 2,560 | 9 | 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| 1 Copper Miners Co. ......... | 248¼ | £2,968 | 1 | 3 |
| 2 Freeman and Co.............. | 272½ | 1,869 | 16 | 9 |
| 3 P. Grenfell and Sons ......... | 281 | 4,602 | 10 | 0 |
| 4 Crown Copper Co. ............ | — | —— | | |
| 5 Sims, Willyams, Nevill & Co. | 44 | 695 | 17 | 0 |
| 6 Vivian and Sons ............ | 21 | 60 | 18 | 0 |
| 7 Williams, Foster & Co....... | 675½ | 6,133 | 7 | 3 |
| 8 British and For. Copper Co. | — | —— | | |
| 9 Mason and Elkington ...... | 51 | 474 | 6 | 0 |
| 10 Bankart and Sons ...... | 8½ | £185 | 6 | 9 |
| 11 Charles Lambert ......... | 449 | 6,424 | 3 | 6 |
| 12 Ravenhead Copper Co. | 177 | 1,785 | 1 | 6 |
| 13 Sweetland, Tuttle & Co. | 92 | 768 | 4 | 0 |
| 14 Jennings and Co.......... | 160½ | 2,030 | 7 | 9 |
| 15 Neath Copper Co.......... | 154 | 1,774 | 8 | 6 |
| 16 Penclawdd Copper Co. | 112½ | 1,266 | 1 | 3 |
| Total .............. | 2,747 | £31,038 | 9 | 6 |

# Black Tin Sales.

| Date. | | Mines. | Tons | c. | q. | lbs. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June | 17. | Kitty (St. Agnes) ...... | 17 | 14 | 2 | 1 ... | — | | ... | — | ...1243 | 0 | 9 |
| | | Penhalls .................. | 4 | 1 | 1 | 16 ... | — | | ... | — | ... 293 | 0 | 0 |
| „ | 19. | Wheal Vyvyan ......... | 2 | 3 | 1 | 22 ... | 67 | 0 | 0 ... | Bolitho & Sons ............ | 164 | 4 | 3 |
| | | „ ......... | 0 | 7 | 3 | 22 ... | 47 | 0 | 0 ... | ditto | | | |
| | | Trevenen.................. | 5 | 1 | 0 | 2 ... | 75 | 0 | 0 ... | ditto | 435 | 13 | 0 |
| | | „ .................. | 0 | 19 | 3 | 22 ... | 58 | 0 | 0 ... | ditto | | | |
| | | Cornubia .................. | 3 | 4 | 2 | 6 ... | 71 | 10 | 10 ... | Daubuz & Co. ............ | 528 | 19 | 5 |
| | | „ .................. | 2 | 15 | 0 | 6 ... | 72 | 0 | 0 ... | ditto ............ | | | |
| | | Wheal Sidney ............ | 5 | 9 | 1 | 4 ... | 73 | 15 | 0 ... | — | ... 402 | 19 | 10 |
| „ | 27. | Phœnix .................. | 7 | 2 | 3 | 8 ... | 65 | 10 | 0 ... | — | ... 467 | 14 | 9 |
| „ | 30. | Great Wheal Fortune | 29 | 6 | 1 | 8 ... | — | | ... | Mellanear ..................... | 2288 | 15 | 5 |
| July | 1. | Great Wheal Busy ...... | 20 | 0 | 0 | 0 ... | — | | ... | — | ...1238 | 0 | 2 |
| „ | 4. | Leeds & St. Aubyn ... | 4 | 4 | 3 | 6 ... | 72 | 5 | 0 ... | Chyandour..................... | 306 | 7 | 0 |
| „ | 8. | Great Wheal Fortune | 29 | 13 | 0 | 20 ... | — | | ... | ditto ......................... | 2268 | 11 | 6 |
| | | Cornubia .................. | 4 | 4 | 3 | 10 ... | 71 | 0 | 0 ... | — | ... 301 | 3 | 7 |
| „ | 11. | East Grenville............ | 4 | 4 | 1 | 11 ... | 74 | 0 | 0 ... | Bissoe Co. ..................... | 362 | 3 | 0 |
| | | Trumpet United......... | 1 | 7 | 1 | 24 ... | 74 | 0 | 0 ... | ditto .................. | 108 | 13 | 0 |
| | | „ ......... | 0 | 2 | 3 | 22 ... | 50 | 0 | 0 ... | ditto .................. | | | |
| | | Wheal Grylls ............ | 20 | 10 | 1 | 14 ... | 70 | 0 | 0 ... | R. Michell & Co. ............ | 1436 | 6 | 3 |
| „ | 14. | Great Wheal Vor ...... | 27 | 1 | 1 | 11 ... | — | | ... | — | ...2026 | 14 | 3 |
| „ | 16. | Great Wheal Fortune | 30 | 6 | 2 | 26 ... | — | | ... | Chyandour..................... | 2313 | 13 | 6 |

# Lead Ore Sales.

| Dates. | Mines. | Tons. | Price per Ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|
| June 25. | Westminster | 20 | 12 | 16 | 6 | A. Eyton | 256 | 10 | 0 |
| | Maesysafn | 80 | 13 | 1 | 6 | ditto | 1046 | 10 | 0 |
| | Mount Pleasant | 5 | 12 | 12 | 6 | Walker, Parker & Co. | 233 | 7 | 6 |
| | " | 5 | 14 | 1 | 0 | A. Eyton | | | |
| | Hendre Ucha | 23 | 13 | 6 | 6 | Walker, Parker & Co. | 306 | 9 | 6 |
| | Bryngwyn | 8 | 13 | 6 | 0 | ditto | 220 | 0 | 0 |
| | " | 8 | 14 | 4 | 0 | A. Eyton | | | |
| | Pant-y-Mwyn | 6 | 13 | 1 | 6 | Walker, Parker & Co. | 222 | 9 | 0 |
| | " | 12 | 12 | 0 | 0 | Newton, Keates & Co. | | | |
| | Dyliffe | 38 | 12 | 18 | 6 | Walker, Parker & Co. | 989 | 18 | 0 |
| | " | 38 | 13 | 2 | 6 | A. Eyton | | | |
| | Roman Gravels | 30 | 13 | 5 | 6 | Walker, Parker & Co. | 398 | 5 | 0 |
| " 29. | Glogfach | 60 | 16 | 0 | 6 | Newton, Keates & Co. | 961 | 10 | 0 |
| | Cwmystwith | 100 | 12 | 11 | 6 | Panther Co. | 1257 | 10 | 0 |
| " 30. | Bronfloyd | 22½ | 13 | 4 | 0 | Sims, Willyams & Co. | 594 | 0 | 0 |
| | " | 22½ | 13 | 4 | 0 | Newton, Keates & Co. | | | |
| July 3. | Minera | 106 | 13 | 6 | 6 | A. Eyton | | | |
| | " | 106 | 13 | 6 | 0 | Walker, Parker & Co. | | | |
| | " | 105 | 13 | 6 | 0 | ditto | | | |
| | " | 80 | 13 | 6 | 0 | ditto | 7526 | 15 | 0 |
| | " | 80 | 13 | 6 | 6 | Mining Co. of Ireland | | | |
| | " | 80 | 13 | 10 | 6 | ditto | | | |
| | " | 8 | 12 | 0 | 0 | A. Eyton | | | |
| | Isle of Man Mining Co. | 100 | 21 | 12 | 0 | R. Michell and Son | 3022 | 10 | 0 |
| | " | 60 | 14 | 7 | 6 | Mining Co. of Ireland | | | |
| | Wheal Frank Mills | 40 | 14 | 6 | 6 | J. and J. Williams | 1527 | 0 | 0 |
| | " | 80 | 11 | 18 | 6 | R. Michell and Son | | | |
| " 9. | Talargoch (Maesyrerwddu) | 51 | 14 | 2 | 0 | Newton, Keates & Co. | | | |
| | " (Coetia Llys) | 49 | 14 | 8 | 6 | A. Eyton | 2132 | 14 | 0 |
| | " | 49 | 14 | 8 | 6 | Walker, Parker & Co. | | | |
| | Deep Level | 12 | 12 | 18 | 6 | ditto | 155 | 2 | 0 |
| | Brynford Hall | 15 | 12 | 13 | 0 | ditto | 189 | 15 | 0 |
| | Rhosesmor | 44 | 13 | 5 | 0 | Newton, Keates & Co. | 1167 | 2 | 0 |
| | " | 44 | 13 | 5 | 6 | Walker, Parker & Co. | | | |
| | Parry's | 30 | 13 | 6 | 6 | ditto | 399 | 15 | 0 |
| | Bryn Gwiog | 40 | 13 | 8 | 6 | A. Eyton | 537 | 0 | 0 |
| | Long Rake | 15 | 13 | 1 | 6 | Newton, Keates & Co. | 196 | 2 | 6 |
| | Speedwell | 7 | 12 | 4 | 6 | ditto | 85 | 11 | 6 |
| | Llangynog United | 52 | 12 | 13 | 0 | ditto | 657 | 16 | 0 |
| | Roman Gravels | 25 | 13 | 2 | 6 | Walker, Parker & Co. | 382 | 2 | 6 |
| | Llanerchyraur | 16 | 13 | 15 | 6 | Newton, Keates & Co. | 442 | 8 | 0 |
| | " | 16 | 13 | 17 | 6 | ditto | | | |
| | Tyndrum | 46 | 10 | 0 | 0 | A. Eyton | 460 | 0 | 0 |
| | Dyliffe | 64 | 12 | 17 | 6 | Walker, Parker & Co. | 824 | 0 | 0 |
| | Dyfngwm | 16½ | 12 | 16 | 6 | ditto | 423 | 4 | 6 |
| | " | 16½ | 12 | 16 | 6 | Newton, Keates & Co. | | | |
| | Wheal Mary Ann | 45 | 25 | 2 | 6 | Stock & Co. | 1130 | 12 | 6 |
| " 10. | Cargoll | 75 | 15 | 10 | 6 | R. Michell and Son | 1224 | 7 | 6 |
| | " | 8 | 7 | 10 | 0 | ditto | | | |
| " 11. | Minera Union | 20 | 12 | 11 | 0 | Sims, Willyams & Co. | 251 | 0 | 0 |
| " 13. | Frongoch | 120 | 12 | 13 | 0 | ditto | 1518 | 0 | 0 |
| | East Darren | 70 | 15 | 13 | 0 | ditto | 1279 | 2 | 0 |
| | " | 12 | 15 | 6 | 0 | ditto | | | |
| | Cefn Brwyno | 40 | 12 | 13 | 0 | ditto | 506 | 0 | 0 |
| | Cwm Erfin | 60 | 16 | 1 | 6 | R. Michell and Son | 964 | 10 | 0 |
| " 16. | Tassan | 40 | 12 | 9 | 0 | Walker, Parker & Co. | 498 | 0 | 0 |
| " 18. | Great Laxey | 100 | 18 | 15 | 6 | ditto | 1877 | 10 | 0 |
| " 23. | Maesysafn | 80 | 12 | 8 | 6 | ditto | 994 | 0 | 0 |
| | Mount Pleasant | 13 | 12 | 4 | 0 | Newton, Keates & Co. | 228 | 12 | 0 |
| | " | 5 | 14 | 0 | 0 | ditto | | | |
| | Hendre Ucha | 5 | 14 | 0 | 6 | ditto | 70 | 2 | 6 |
| | Bryngwyn | 8 | 12 | 17 | 6 | Walker, Parker & Co. | 204 | 8 | 0 |
| | " | 8 | 13 | 18 | 6 | ditto | | | |
| | Merllyn | 5 | 12 | 8 | 0 | Newton, Keates & Co. | 62 | 0 | 0 |
| | Nant-y-Iago | 17 | 11 | 17 | 6 | ditto | 201 | 17 | 6 |
| | South Exmouth | 30 | 10 | 2 | 6 | Panther Co. | 303 | 15 | 0 |

THE

# MINING AND SMELTING MAGAZINE.

SEPTEMBER, 1863.

## Some Considerations on the Processes employed in Refining Iron and Steel.

BY WILLIAM BAKER, ASSOCIATE OF THE ROYAL SCHOOL OF MINES, F.C.S.

THIS is emphatically the iron age, and the methods of elaborating this pre-eminently useful metal from its ores, and of preparing it for its manifold purposes, are so time-honoured, and have carried the manufacture to such a pitch of greatness, that it might be thought at first idle, if not presumptuous, to question their correctness, or to propose any alterations. Nevertheless, the successful production of large quantities has not unfrequently been accompanied by a sacrifice of quality. Quantity has been the cry of the day, and now that a demand for better quality is becoming more urgent, it will be not unprofitable to review the processes employed for producing a pure iron, and to compare them with similar operations applied to other metals.

It must be premised that the term pure iron or pure steel applies to the three forms in which the metal is used, viz., cast-iron, steel, and wrought iron. Carbon only, of the other elements which may exist in the metal, is not considered an impurity, as upon its presence in certain proportions depend the physical characters which determine to which of the above categories it belongs.

When copper or lead is smelted from moderately rich ores in a blast furnace, the operation is exactly similar to the smelting of iron. The carbon of the fuel combines with the oxygen of the metallic oxides, and the metal is eliminated or reduced, whilst such proportions of earthy bases and silicic acid are brought together as will make a fusible slag. At the moment of reduction, should there be certain elements present for which the metal has a strong affinity, they will be carried down with it, and the product will be more or less impure. But when copper is poured into an ingot from the furnace, we know that it will be the best copper, if

there is absolutely nothing but copper in the ingot. Similarly of lead; there is no combination of lead with any other element that can improve its character as lead for its uses in the arts. Both metals can be extended by rolling or hammering, and, according to their crystallisation, will possess a fibre when drawn out. It is otherwise with iron. A strong affinity for carbon, which in different proportions singularly modifies the physical characters of the metal, complicates the after processes of refining. The crude pig-iron then always contains carbon, and not only in various proportions, but also in two distinct conditions. At the first operation in copper smelting, besides the crude metal, a slag is obtained, poor enough to be thrown away. In smelting iron the slag is also rejected as worthless, but the crude product may be—1st. White iron, in which the carbon is wholly chemically combined. 2. Grey iron, in which it is chiefly in the form of graphite. 3. Mottled iron, being a mixture of the former two varieties. The impurities which may be present in iron are chiefly sulphur, phosphorus, silicon, and manganese; more rarely traces of copper, lead, arsenic, nickel, zinc, and titanium. It is possible, by a judicious regulation of the charge, and by observing certain precautions, that some of these impurities may be slagged off in the first operation in the blast furnace. A coal or coke as free as possible from sulphur should, of course, be used—yet, notwithstanding, sulphur is always found in the iron. Phosphorus, when contained in the ore as phosphoric acid, is, unfortunately, transferred almost entirely to the iron in the process of smelting. This has been very well proved by Dr. David Price and Mr. Nicholson. (*Vide Chem. Gazette.*)

The hot blast may be said generally to introduce more of these impurities than the cold blast, which fact in itself illustrates the remark that, at this early stage in the production of the metal, something may be done towards improving its quality. There may however, be no need to take the retrograde step of smelting only with cold blast. The problem for the metallurgist is to take the crude pig-iron, smelted by the hot blast, and eliminate its impurities.

The operation of refining crude copper is a roasting or oxidising process, and produces rich slags, which are utilised in the first smelting furnace, along with the ore. The crude metal has carried down with it arsenic, phosphorus, sulphur, lead, and antimony—not to mention some of the most common impurities. Now, as their united amount is small in comparison with the mass of copper, an oxidising process will eliminate them at the cost of a certain amount of copper. The impurities, therefore, are burned off, giving rise to rich oxidised metallic slags. In this case it so happens that, in the order of combustibility, copper burns last of all.

Impure lead is treated in a similar manner. From 8 to 10 tons are melted in a rectangular pan, about 8 inches deep; an oxidising flame plays over the surface of the metal, and the oxidised impurities are separated as rich dross, containing, of course, a great deal of lead; and the metal is purified. Lead, however, is *not* last in the order of affinity for oxygen at the temperature employed; for copper refuses to oxidise to any extent as long as it is in contact with lead,

at least when the proportion is reduced to a certain quantity, which may be roughly stated at 20 ozs. per ton. When much copper is present, it forms combinations with antimony and sulphides of lead less fusible at the temperature employed than lead, and can then be partially separated by skimming off the dross; but copper alone with lead cannot be removed by an oxidising process; still, the chief impurities are oxidised, and give a rich slag, containing a considerable amount of the oxide of the metal to be refined.

If crude pig-iron be submitted to any oxidising process, many impurities would likewise be burned off with a certain waste of the iron itself. But we are stayed here by the consideration that we should also burn off the carbon, perhaps before the impurities would be oxidised, and the nature of our charge would be essentially altered. Thus, if the metal contain no more than 0·6 % of carbon, it is wrought iron; with 0·65 to 2·3 %, it is steel; and with 2·3 to 5·75 %, it is cast iron. These degrees are only valid, however, on the consideration that (1) every malleable iron hardening on quenching, and giving sparks, is steel; and (2) that separation of graphite on slow cooling and non-malleability in the cold, are characteristic of cast-iron. Supposing, therefore, we desire to obtain a pure cast-iron, theoretically, we should submit it to an oxidising flame, and find some means of constantly supplying the carbon necessary for its constitution. This is, to some extent, accomplished in the *finery* furnace. Pig-iron is melted down with coke, under a blast from 6 or 8 twyers inclined downwards to the hearth. As the metal melts, silicon is oxidised, and, in the form of silicic acid, combines with oxide of iron, giving rise to a slag containing some of the impurities. Finery iron is most free from silicon; and some phosphorus, sulphur, and a little carbon may be removed in this operation. The product is always white iron, and breaks with a radiating crystalline fracture. The finery furnace in this country is chiefly used as a preliminary step to the operation of puddling. In the puddling furnace we come to the true roasting or oxidising process, although its object is not to refine the metal, but to convert it into wrought-iron by eliminating its carbon. Finery iron has no direct application in the arts. Price and Nicholson have patented its use for mixture with bar-iron to produce a steel, and with pig-iron for casting ordnance, much stress being laid upon its freedom from silicon.

The puddling process is conducted in a reverberating furnace. The metal, either pig-iron or finery metal, is melted down with the addition of finery slags, or red oxide of iron, which yield oxygen to the metal. As the impurities burn off, and the carbon also is consumed, the metal gradually assumes a pasty consistency, and is brought together in lumps or balls by the workman manipulating with an iron crook. From this point the process cannot be looked upon as a satisfactory refining operation. From the moment the metal loses its fluidity, it is difficult to see how foreign bodies can extricate themselves from the spongiose mass, for fluidity is essential to the separation of unlike particles of matter. As it is, the balls are kneaded with great effort, as well as skill, the result being a mass of iron dripping with slag; which, however treated—by

the steam hammer, the squeezer, or the rolls—must always contain minute portions of slag, which tend to destroy the continiuty of its texture. The theory of the puddling process is simple: an oxidising flame plays over the charge, the action being assisted by the cinder which covers the melted metal; and the carbon, sulphur, phosphorus, and silicon, become oxidised by the united action of the oxygen of the air and that afforded by the fluid cinder, which may be roughly stated to be generally a tri-basic silicate of iron. With any other metal these slags would be reworked for the metal they contain; which is, however, done to a very limited extent with iron, as metal made from cinder is reputed bad in quality. We are happily circumstanced in having an abundance of iron ore; but were it not so, necessity would have surely found out a method of producing a fair quality of metal from these slags, which, for richness, may compare with some of the best iron ores. In the puddling process the cinder is a real chemical agent; for it will be seen, that from the time when the pigs have melted down and become covered with the fluid slag, the oxygen of the air passing through the furnace cannot act directly on the iron, but is transferred by the agency of the oxides of iron in the cinder. The carbon in the iron reduces the higher oxides in the slag; and the reduced oxide, by the boiling movement caused by the evolution of carbonic oxide gas, comes to the surface to take up again oxygen from the air. A much more powerful chemical agent has been employed by Mr. Charles Sanderson, who proposes to use sulphate of iron as an oxidising and purifying agent in the puddling process. The substance is one which readily furnishes nascent oxygen, and only chemists can appreciate the vastly more intense energy of nascent than free oxygen. I am inclined to think that, properly applied, this plan would be very successful. Working upon another metal, I have met with an exactly similar case, which it is worth while to adduce in illustration. Thus, when lead is alloyed with antimony to the extent of about 2 % of the latter, and where a certain amount of sulphur is present, it differs remarkably from pure lead in its behaviour when it is melted and exposed to the air. Its surface is smooth as a mirror, and it may be rabbled or splashed about without undergoing much oxidation; whilst under similar conditions, pure lead rapidly oxidises and becomes covered with a dross of litharge. Upon presenting any substance that will liberate nascent oxygen at the temperature of melted lead, the sulphur and antimony are immediately attacked and oxidised. It is quite possible that combinations of iron with phosphorus and sulphur, which resist the action of the air, would be readily attacked by nascent oxygen; so that when refining processes are essentially oxidising processes, it is worthy of consideration whether they might not be assisted by chemical agents yielding nascent oxygen at the temperature employed.

The desirability of a mechanical puddler has long been felt by the iron masters, and the strike now existing in Staffordshire has again brought the question prominently before the public. Two plans may be mentioned as offering the most promising improvements on the present method. One may be shortly described as a

cylindrical furnace bed, which is rotated whilst the flame passes through—causing a sort of churning of the iron in its bath of melted cinder. The other plan, lately described in the *Mining and Smelting Magazine*, is an adaptation of levers to the tool at present used by the puddlers, whereby the same work is done in an easier manner. When machinery takes the place of manual labour, the systems of apparatus between the moving power and the work to be done are seldom alike in aspect. We might look in vain for a resemblance to the stocking knitters' needles in the elaborate mechanism of the power looms. I am inclined to look upon Bessemer's process as the mechanical puddler of the present day; for in that process we have the power of burning off the carbon and pouring out molten wrought-iron. This is in the same direction as the puddling process, but goes a step beyond. In the Bessemer process, oxidation may be carried on until all the carbon is removed, whilst all the time the metal is kept in a fluid state; so that here are all the conditions most favourable to the removal of impurities. If the foreign elements present can be burned—if they have any affinity for oxygen—surely the streams of air passing through the fluid metal, agitating and causing every particle to come into contact with oxygen, will eliminate them along with the carbon. But what does the experience of the steel manufacturers teach us on this point? If the purest steel is required to make articles of fine cutlery, and the Bessemer process produced a pure steel, we might expect to find a few at least of the Sheffield manufacturers actually using this process. But on the contrary, its adoption for the purposes indicated seems very slow.

This practical result accords with what has been shown by chemical investigation. It has been found that of the impurities commonly present in iron, one, especially objectionable,—phosphorus—is not removed; that is to say, phosphide of iron melts and dissolves in the molten iron, and appears to be unoxidised in contact with air at the high temperature employed.

We must reserve, however, any final opinions on this matter until more experiments have been made. It must be recollected that the nature of the process limits the time of purification: whilst the combustion of the carbon, and a portion of the iron itself, maintain it in a state of complete fluidity, it is possible that by continuing the action for a longer time, phosphide of iron might be removed. A Bessemer apparatus is not easily fitted up in a chemist's laboratory for experiments, although many very important facts have yet to be learned by its means. Amongst others—whether a neutral blast, that is, one not oxidising in its action, could not be obtained by a mixture of gas and air. By such means the metal might be kept melted, if necessary, a longer time without injury to its quality. It is also extremely probable that a better way of putting in the dose of carbon might be discovered; for after all, however good the Spiegeleisen may be which is employed, it is a crude form of the metal. Again, if carbon in some form could be supplied to keep up the temperature longer than the time necessary to burn off the carbon contained in the pig iron, advantage might safely be taken of more powerful oxidising agents along with the blast.

As regards the regular cementation process for making steel, we find no special methods of obtaining any purification between the bar iron and cast steel. In the cementation cases, it is obvious none but gaseous substances could be eliminated. It is not unlikely that such deleterious elements as phosphorus and sulphur might be got rid of in that form, if the iron were treated with a current of hydrogen. It is quite possible that we may arrive in practice to a cementation in a gaseous current. When blister steel is broken up, assorted according to its temper, and melted, there is yet a slight chance of a refining action. Many have been the nostrums recommended for melting with steel, but only those can be of any use which make a readily fusible slag with the silica and oxide of iron eliminated on melting. The manganese ore (pyrolusite) in common use answers this purpose extremely well. When the steel has once been well melted, no good can be gained by allowing it to remain in the pot; what the manganese had to do, is accomplished, and there is no movement of the steel to bring up from the bottom any particles of impurities to be oxidised.

The question of the constitution of iron and steel is extremely interesting at the present time, as several eminent chemists are working upon it, and have advanced some novel opinions. Lest it may be considered that I have taken rather a narrow view of the subject, it must be stated that the ideas of M. Frémy and others have been purposely kept out of the discussion. Cast iron and steel, and *one* essential element of their various kinds, viz., carbon, have been considered. M. Frémy imagines that there may exist a variety of steels, in which the carbon may wholly or partly be replaced by silicon, titanium, phosphorus, and other matters; and he has laid some stress upon the presence of nitrogen. Now if a steel can be produced possessing useful qualities, made, say, with silicon instead of carbon, it is an object of our serious regard, and we would anxiously examine its qualities and properties; but, if experiments have merely shown that these substitutions can be made in the same way that oxide of iron and chromium may be made to replace alumina in common alum, then these results do not afford us the material we require—the well known metal, carbide, or combination of elements—steel proper.

The present time is exceedingly favourable for a review of the entire subject. Many well recorded facts have accumulated,—the methods of analysis have been much improved. A new series of well-selected samples and a methodical investigation would not fail to show what is essential to good steel. In this sketch, a broader view has been suggested of the methods of refining, by comparing them with processes used in purifying other metals, whilst keeping in view the chemical principles involved in the operation. If the best iron for technical purposes be iron *per se*, or if it be iron, *plus* a certain amount of carbon, nitrogen, or other element, the problem is a fair, and by no means impossible one, for the modern metallurgist to solve: it is in the one case to eliminate all foreign bodies, and in the other, having obtained pure iron, to add the elements essential to its valuable qualities.

# On Copper Refining.

## By C. Stetefeldt, Mining Engineer.*

(Concluded from page 79.)

III. On the Theory of the Process.—While the black copper is being melted down, a large portion of the foreign metals it contains, particularly iron, zinc, and cobalt (when the latter is present, as is the case in the Mansfeld ores), is converted into slag, either directly or by the influence of the $Cu^2O$ ($\dot{C}u$ dioxide) present. When the metal has become perfectly fluid, and has been freed from slag, the oxidation-air passages are opened, and a very lively formation of $Cu^2O$ commences; which dioxide possesses, as we know, the property of completely combining with melted copper, and of forming with it a homogeneous compound—by which indirectly a slagging of the foreign constituents ensues. When the copper has taken up a sufficient quantity of $Cu^2O$, and when the temperature has been lowered, a very energetic reaction takes place between the $Cu^2S$ and the $Cu^2O$, the resulting $SO^2$ (sulphurous acid) causing, in its escape, the phenomena which we have termed spitting (copper-rain), roasting† (*braten*), and working. The spitting (copper-rain) is only observed when the quantity of sulphur contained in the black copper is rather considerable, which is the case with all black copper produced in a cupola furnace. In the refining at the Aggerthal works, copper-rain is never observed, because the black copper is there produced by smelting in a reverberatory furnace, which, as a rule, to a considerable extent refines the metal: that is to say, the proportion of $Cu^2O$ is diminished, so that a much smaller quantity of sulphur remains.

If the decomposition of the $Cu^2O$ be required to go on with such energy, that a development of gas may be clearly remarked, the maintenance of a relatively low temperature is absolutely necessary. The writer had the opportunity of convincing himself of this at the Aggerthal works; for while a less experienced and intelligent workman kept the temperature high after the melting down, another, more experienced, when he managed the process, took care to lower the temperature. In the first case the metal always remained quiet —while with a low temperature it began to work. In the course of the writer's observations he thinks he has remarked that if the copper is not allowed to work, it requires much more trouble to make it compact.

It may perhaps not be uninteresting to estimate approximately, from the volume, the quantity of $SO^2$ which, in the Mansfeld district, is formed during a refining charge, and the greater part of which is given off in the copper-rain and roasting. The Mansfeld black

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* From the *Berg- und Hüttenmännische Zeitung*. Nos. 22, 24, and 25, 1863.

† The translator, in our last number, rendered *braten* by the English word "baking," to distinguish it from *abrösten*, which is used in the same sense as "roasting" is used by English copper smelters.—Ed. M. & S. M.

copper contains on an average 1 % of sulphur. The total amount of sulphur therefore, contained in a charge of 100 centners is 100 pounds, which, combined with the oxygen required to form $SO^2$, gives 200 pounds of $SO^2$. It may be assumed that all sulphur passes off as $SO^2$, for according to analysis the refining slags contain no sulphur. A thousand cubic centimetres of air weigh 1·2932 grammes; the density of the $SO^2$ equals 2·247, therefore 1,000 cubic centimetres of $SO^2$ weigh 2·9085 grammes. As one pound Prussian equals 462·711 grammes, 200 pounds of $SO^2$, at zero Cent. (32° Fahr.) and 28 inches of the barometer, fill a space of 32,200,000 cubic centimetres. But at a temperature of 1500°, which may be taken as not too high for the refining furnace, this 32,200,000 cubic centimetres of $SO^2$ would expand to 177,261,000 cubic centimetres, or 177·261 cubic metres (6,260 cubic feet). This amply and clearly explains the occurrence of a phenomenon like copper-rain, which pre-supposes a very lively development of gas.

The *rising-up* also, as to the causes of which the most surprising hypotheses were formerly advanced, is undoubtedly produced by the escape of $SO^2$—of which we can clearly convince ourselves so long as the phenomenon occurs with any activity, by the odour given off. Although this is impossible later on in the process;—particularly when the subsequent rising-up results from a bad management of the operation, caused by the premature lading out of the copper which the workman incorrectly believed to have attained a compact and tough condition;—still the characteristics of the phenomenon are so analogous to those observed at an earlier stage, that an attempt to give any other explanation to the action, without strong grounds, would be received with considerable scepticism.

Now, although it is thus evident that the rising-up is caused by a development of $SO^2$, it is yet doubtful whether the phenomenon is produced by the reaction which takes place, during the cooling of the copper, between $Cu^2S$ and the $Cu^2O$; or whether the decomposition had already taken place, and the $SO^2$, which had been absorbed on its formation by the melted copper, was merely again given off on solidification. If we thoroughly examine the matter we find that the rising-up does not occur with the greatest intensity so long as the visible reactions between the $Cu^2S$ and the $Cu^2O$ are observed in the form of copper-rain and roasting,—but that it first takes place with activity when the greater portion of the sulphur is oxidised; and this enables us to give the following simple explanation of the occurrence. After the copper-rain and working are finished—the greater portion of the $Cu^2S$ being decomposed and the foreign metals mostly removed,—the copper assumes the property, while in a hot fluid condition, of holding absorbed the $SO^2$ formed by the further oxidation of the $Cu^2S$; but which sulphurous acid is again parted with at a low temperature and on solidification.

This view is also supported by the effect which, in the Mansfeld district, is produced by the *compact poling*, which begins at that period when the copper rises with the greatest intensity, and, consequently, when it has absorbed a maximum of $SO^2$. Compact-poling acts in various ways: 1. Chemically, by reducing the dioxide; and Mechanically, by the action of the immense quantities of gases

which escape during the carbonisation of the birch-pole, expelling the $SO^2$ absorbed. The mechanical action also induces a chemical one, for the continually active movement of the surface of the metal gives rise to a lively formation of slag. The poling further causes a lowering of the temperature, and thus brings about the escape of $SO^2$. The removal of the sulphur by the poling could not indeed be explained if we were to assume that the sulphur is still present as $Cu^2S$, because then the reduction of the $Cu^2O$ in the poling would rather tend to the maintenance of the $Cu^2S$.

We may take this opportunity of making a remark on poling. From the description preceding it will be seen that in the Mansfeld district there is a complete distinction between *compact-poling* and *tough-poling*, which is not the case at the Aggerthal works. In the latter, the object is more to remove the greater portion of the absorbed $SO^2$ by continuing the oxidation as soon as the proofs show a maximum rising-up; the $SO^2$ being removed by the introduction of very large quantities of $Cu^2O$, as is evidenced by the proofs, which later on always rise up less. In the writer's opinion an early poling, repeated and powerful oxidation, and continued poling, would effect the removal of the sulphur with far more quickness and certainty than when the poling is begun later, and a powerful oxidation is thus prevented. By the former method there is far less risk of obtaining an uncompact copper, and in the toughening, the attention is only required to be directed to the proportion of $Cu^2O$ contained in the copper. The writer had the opportunity of convincing himself of this at both places.

From the description given of the two modes of refining, at Mansfeld and Aggerthal, it will be remarked that the proofs taken in the former district have very different characteristics from those taken at the latter works. The Mansfeld proofs were particularly distinguished by the *boundary*, a phenomenon never observed at Aggerthal. It would be interesting to ascertain whether this phenomenon would occur at Aggerthal if the poling were begun at the same time as at Mansfeld. A nearer investigation of the characteristic changes which the proofs undergo in the course of the process might lead to interesting results.

We now come to a highly important question in the theory of copper refining, that is—What is the effect produced by too long a poling during the toughening stage of the process? Or, in other words, What is the chemical constitution of a so-called *overpoled* copper (named also by German smelters *too young* copper)? We may consider this under the three following heads: (*a*) Whether overpoled copper contains carbon; (*b*) Whether its inferior quality is caused by having taken up other bodies; or, (*c*) Whether it is attributable to the entire reduction of the $Cu^2O$.

(*a*). As already remarked in the description of the Mansfeld refining, most practical men are of opinion that overpoled copper has taken up carbon, after the last traces of the $Cu^2O$ were reduced, but no one is in a position to support this hypothesis by analytical data. This opinion, as to overpoled copper containing carbon, which at first sight certainly seems very probable, is particularly insisted upon by Karsten, and seems to be deeply rooted in his mind. In his "*System*

*der Metallurgie*," vol. v, he says "The carbon lessens the tenacity of the pure copper at a high temperature so much that, if the proportion of carbon amounts to 0·2 %, it will not stand a dull red heat, but crumbles under the hammer. When the proportion of carbon does not even exceed 0·05 %, the pure copper cannot be worked at a high temperature without splitting into laminæ and cracking at the edges. The brittleness of the copper increases in a still higher degree if a copper, containing zinc, antimony, lead, &c., takes up carbon."

"It is very difficult," remarks Karsten in another place, "to determine with certainty the highest amount of carbon which may be taken up by the copper. According to my researches, it appears that copper cannot take up more than 0·2 % of carbon, but that it can combine with it in all proportions from this maximum down to a scarcely perceptible trace. This maximum combination, which is distinguished by its pale yellowish-red colour, and very strong metallic lustre, is best arrived at by imbedding pure copper in lamp-black, then exposing it for some hours first to a strong red heat, and afterwards to the melting-point of copper."

In order to determine the quantity of carbon, Karsten adopted the following method of analysis. The copper was left in an aqueous solution of $AgO,NO^5$ (nitrate of silver), so that the carbon, together with the precipitated metallic silver, remained undissolved, while the copper was completely dissolved in the state of nitrate. The silver in the residue is then dissolved by dilute $NO^5$ (nitric acid), and the carbon remains behind. Karsten himself anticipates the objection to this mode of proceeding, that the carbon in this finely divided state might be more or less oxidised by the nitric acid employed to remove the metallic silver. But the worst is, he assumes without further proof that the whole of the undissolved residue is carbon, although presenting us with no evidence whether this is wholly or only partially the case.

This important subject has lately been carefully investigated by Mr. A. Dick (see *Berg- und Hütten. Zeit.*, 1856, p. 345, and Percy's "*Metallurgy*," p. 275). As these researches may not be generally known we shall give the results of the most important of them.*

1. A specimen of "best selected" copper, which had been prepared with particular care, was reduced to the finest powder, then mixed with powdered wood-charcoal, and heated in a covered crucible during many hours, at about the temperature of melted copper. When cold the copper was found diffused through the charcoal in the form of small round shots. The charcoal was removed and the residual copper was smelted in a crucible under charcoal powder, and cast in a mould. The ingot was rolled without cracking at the edges, and the rolled metal could be drawn out into the finest wire.

2. Electrotype copper, melted in small pieces under charcoal, could be hammered out without cracking, whether cold or hot.

3. Several pieces of electrotype copper were placed in a brasqued

* These will all be found in Dr. Percy's *Metallurgy* from pp. 270-273.—Ed. M. & S. M.

crucible, which was then completely filled with charcoal powder, covered, and exposed to a temperature approaching whiteness for about an hour. The copper thus treated was remelted under similar conditions and sent to be rolled. It rolled well into thin sheets and fine wire, and the report received from the rollers was that, although the casting was not good, the metal was fit for any work.

4. A piece of the sheet obtained in the last experiment was perfectly purified by means of caustic potass, and was laid in a platinum basin, immersed in a solution of sulphate of copper. The basin was connected with the positive pole of a voltaic battery, and a plate of copper connected with the negative pole was fixed in the solution above the basin. The whole was protected from dust, and left until the residue from the copper in the basin was very small. It still contained a little metallic copper, which was dissolved out by a solution of $Fe^2 Cl^3$ (sesquichloride of iron). The insoluble residue weighed 0·08 grain, while the sheet of copper submitted to the solution had weighed 221·10 grains. This residue was a very dark grey, nearly black. When a portion of it was heated on a platinum foil, it evolved a slight and peculiar odour, glowed for an instant, and left a small amount of fixed matter. Another portion, weighing 0·012 grain, was introduced on a very small piece of platinum foil into a small glass tube, of which one end was dipped into baryta water, and the other connected with an apparatus from which a current of air could be sent. When that part of the tube containing the platinum foil was heated, a very slight deposit of the colour of sulphur appeared in the cold part of the tube. When the platinum foil became red hot, every bubble of air, as it traversed the baryta water, caused a white precipitate which dissolved with effervescence on the addition of hydrochloric acid. The residue upon the platinum foil weighed 0·003 grain. The weak point in this evidence as to the presence of carbon is, that the precipitate in the baryta water might have been $BaO,SO^3$ (sulphate of baryta) and not $BaO,CO^2$ (carbonate of baryta), as the copper employed in the foregoing experiment was afterwards found to contain 0·05 % of sulphur, and the small yellow deposit was at all events sulphur.

5. About 672 grains of filings of electrotype copper, which first, like the former, had been melted under charcoal, was mixed with $PbO,CrO^3$ (chromate of lead) in a combustion tube connected with a Liebig's potash-apparatus. At the end of the process the potash-apparatus was found to have increased 0·115 grain in weight. Assuming this to be $CO^2$(carbonic acid), aud that the whole of the carbon supposed to exist in the copper had been converted into $CO^2$, this 0·115 grain corresponds to 0·0046 % of carbon.

It must be admitted that the preceding data do not surely establish the fact that copper melted under, or exposed to a high temperature in contact with, charcoal does combine with carbon; but it seems certain that if copper has this power, it can only combine with a very minute proportion of carbon. But there is one point of practical importance which is proved by the foregoing experiments, namely, that comparatively pure copper is not rendered brittle by being melted in contact with comparatively pure charcoal at a high temperature.

(*b*). Overpoled copper may also have taken up other substances besides carbon, and specially phosphorus and silicon. The means of separating these elements are obvious, since all wood-ashes contain phosphoric and silicic acids—but which are reduced by carbon at a high temperature. Percy prepared copper containing 1·82 % of silicon by heating it to whiteness in contact with silicic acid and carbon. The siliciuretted copper much resembled gun-metal in colour, was harder than copper, might be rolled and hammered out while cold, but immediately cracked at a red heat by this treatment.*

In the same way, copper containing phosphorus may be produced by melting copper filings with carbon and phosphate of lime. Phosphorised copper is more red- than cold-short, and has, at the fracture, a granular texture and a grey colour.

(*c*). Karsten has already remarked that copper which is not perfectly free from foreign constituents is essentially improved in quality by the presence of a certain portion of $Cu^2O$, since the $Cu^2O$ diminishes the red-shortness which is principally induced by the admixture of foreign substances. Mr. Dick has communicated some new investigations on this subject, from which it appears that all ordinary commercial copper, when at the maximum toughness, contains a greater or less quantity of oxygen; and the proportion of oxygen is the greater the more the copper contains admixtures of foreign metals, such as antimony, lead, &c. Thus, for example, the proportion of $Cu^2O$ in a copper which contains 0·29 % of Pb and 0·31 % of Sb would be determined at 3·37 %.

If ordinary copper is melted under charcoal, the more impure it is the more brittle it becomes. This brittleness is not, as we have seen, produced when the copper is chemically pure; but it takes place when the reduction of the $Cu^2O$ has been effected, during the melting, by hydrogen gas, from which it is to be presumed that the diminished malleability results from the abstraction of the oxygen. If thin wire or leaves of commercial copper be brought to a red heat in hydrogen, sulphuretted hydrogen, or carbonic oxide, gas, they will become brittle. The brittleness thus induced seems to be due to the porosity occasioned by the reduction of the $Cu^2O$, and must be distinguished from the brittleness which the copper acquires by being melted in any of these reducing gases.

From the above considerations it will be seen that overpoled copper may be of very various qualities. Copper with comparatively large quantities of foreign substances is overpoled as soon as it contains a smaller quantity of $Cu^2O$, with respect to the oxygen, than that which is necessary for neutralising the foreign constituents. The more easily the overpoling takes place the greater is the quantity of oxygen which must remain in the copper, which perfectly corresponds with experience, for it is far more difficult to bring the inferior sorts of copper to the maximum tough-pitch than the superior kinds. In overpoled copper of a moderately pure quality, and in highly overpoled impure copper, the whole of the $Cu^2O$ is reduced. If the poling is continued beyond this point it is highly probable that the copper takes up no carbon, but first silicon and then phosphorus. The physical characteristics of overpoled copper support this view. It is first yellowish-red, and then grey with a metallic

lustre. The first condition belongs to siliciuretted copper, the latter to phosphorised copper. Whether the whole of the oxygen is really present as $Cu^2O$ in tough pitch copper containing oxygen, or whether it forms oxides with the foreign metals is a difficult question to decide.

In conclusion, with respect to the *rising* of the tough copper when laded out. Many practical men are of opinion that the copper rises upon being laded, if it has too high a temperature. Although this cannot be contradicted, yet the writer is of opinion that in such cases the excessive temperature only produces an indirect effect, and that such copper contains a trace of sulphur. If the copper solidifies too slowly a molecular movement is originated from the surface to the interior, and the copper takes up $Cu^2O$ which then reacts on the sulphur present. This is perfectly in accordance with Percy's observation that under these circumstances no rising is remarked when the casting and solidification have taken place in a reducing atmosphere. Nothing is generally known about this, because native copper contains no sulphur; but this is quite natural, for it escapes from the copper even in the rising up. This will appear more probable from the following calculations. We may assume that tough pitch still contains 0·0001 % of sulphur, which, as such, is not injurious to the copper. This copper by being laded out at a very high temperature again takes up so much $Cu^2O$ that an oxidation of the sulphur is produced. If only 50 % of the sulphur were by this means converted into $SO^2$, the result would be that in an ingot of 100 pounds 177·26 cubic centimeters of $SO^2$ at 1500° would be evolved, and the remaining copper would contain 0·00005 % of sulphur. In order to determine this proposition with certainty 10,000 grammes must be subjected to analysis.

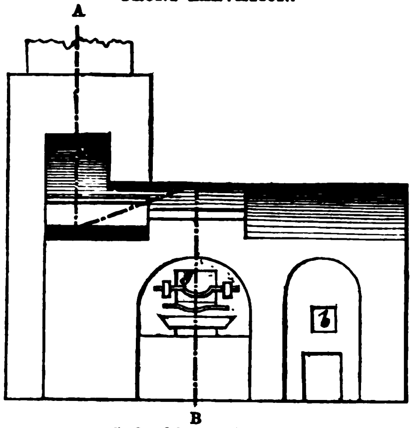
## Lead Smelting in Carinthia.

By F. Thum.*

As is well known, lead-smelting in Carinthia has long been carried on in reverberatory furnaces—a process which is specially suitable to the nature, and conditions of occurrence, of the ores of that district. These ores are generally found in the middle beds of the Alpine limestone—from which they derive their eminently calcareous character, and are indebted for their great purity; at their principal points of production they are almost entirely without silver, but are frequently associated with zinc-blende and calamine. With some exceptions, these lead ore deposits generally occur in irregular and frequently wedge-like masses, which constantly cut out; after which no hope of further discovery can be entertained until considerable additional explorations have taken place. To these conditions the ordinary Carinthian smelting-process is very well fitted; for while

* From the *Berg- und Hüttenmännische Zeitung*. No. 23, 1863.

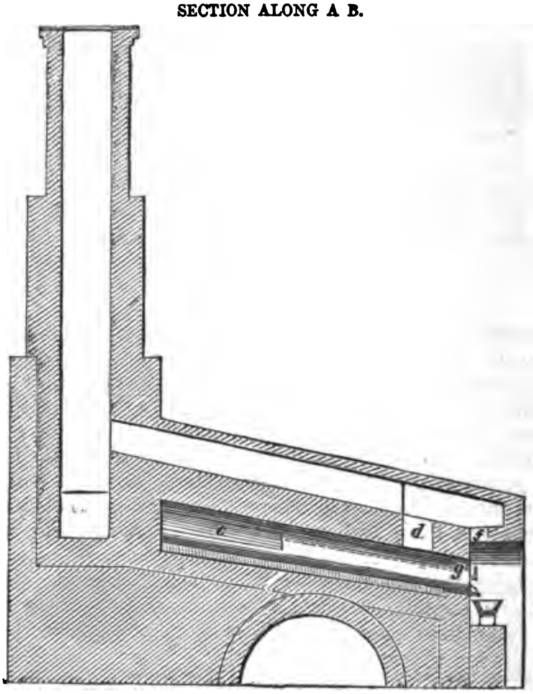
FIG. 7.
FRONT ELEVATION.




Scale of figs. 7-10, $\frac{1}{72}$nd.

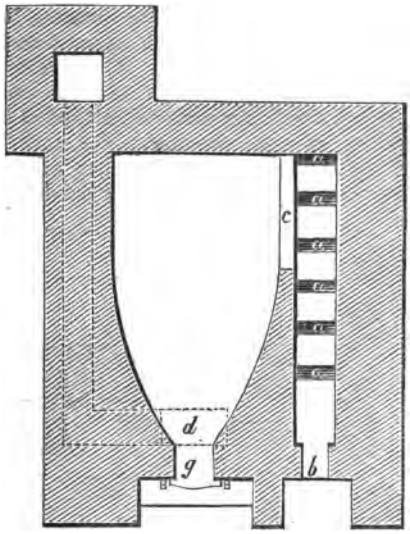
on the one hand the purity of the galena, and its eminently calcareous accompanying gangues are suitable to the reverberatory-furnace process—on the other hand the extreme simplicity and

FIG. 8.
SECTION ALONG A B.



cheapness of the smelting appliances, allow of profits being made on a smaller production than could be expected under any other process.

FIG. 9.
HORIZONTAL SECTION.



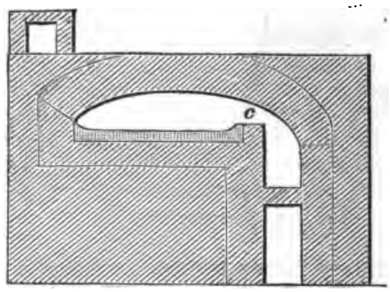

The reverberatory furnaces used are essentially alike at all the principal works of the district; for the trifling differences of dimension which may perhaps be found, seem to be unimportant—at least they have no connection with those essential changes in the percentage of the ores, or in the nature of their gangues, which may often be remarked at certain works. The dimensions of the furnace shown in figs 7, 8, 9, and 10 are those of the one at present in use at Raibl; and the principal difference between it, and that employed at Deutsch-Bleiberg, is that at the latter place the breadth* of the openings in the grate are only $2\frac{1}{4}''$, and that of the fire-place only 14″. The bed of the furnace at Bleiberg is 10′ 4″ long, by 4′ 10″ wide—and the fire-bridge is 4′ 2″ long, $5\frac{1}{2}''$ broad, and leaves an opening only $6\frac{1}{2}''$ deep; while the flue has but a width of 9″. As will be seen from the drawings, the sole of the bed has an inclination of $9\frac{1}{2}°$ towards the working door, situated *g*, at the narrow end of the furnace. The fire door *b*, situated at the same end of the furnace, opens to the fire-place, which is constructed alongside of, and in the direction of the length of, the bed, and with the same inclination. From this fire-place there are six openings to the ash-pit, formed by the spaces left between the slabs of sandstone. As the fuel used generally consists of logs of wood about 3′ long, an iron grate is not absolutely necessary, although it would, perhaps, be found advantageous as regards the consumption of fuel. The opening to the flue (*d*) is

* The measures given here are Vienna feet and inches. The Vienna foot = 12·445 inches; and the Vienna inch = 1·0371 inches.

just in front of the working door, communicating to the flue passing over the furnace—which is generally common to two furnaces, and which leads into the common stack. At the working door *g* a cast-iron plate is fixed, hollowed out in the middle, which enables the lead to flow directly into the mould placed underneath. In order to facilitate the working of the tools in the furnace, hooks are built in on each side of the working door, which support an iron bar that can be removed and replaced at pleasure. The materials of which the furnaces are constructed are almost always the ordinary brick, and the bunter sandstone, the latter material, although containing a considerable percentage of iron, proving sufficiently fire-proof for the interior parts of the furnace. Only the mere sole of the bed is constructed of refractory clay, which, as will be seen from fig. 10, is

FIG. 10.

VERTICAL SECTION.




rounded at the sides, by which arrangement, combined with the inclination of the sole in the long direction of the furnace, the metal is enabled to flow off from all parts to the working door. This sole has generally to be renewed every four or five weeks; while the other parts of the furnace last on an average from five to six years.

In order to avoid any considerable loss of lead from the fissuring of the sole, it must, after being laid down, be perfectly dried, upon which it may be subjected to a gradually increasing temperature; afterwards the smelting of the lead, and of the slags containing oxide of lead, give rise to a tolerably compact glaze, which prevents any further absorption of lead during the subsequent working.

(*To be continued.*)

# On the Manufacture of Pig-Iron in England.

BY MM. GRUNER AND LAN.

(Abstracted from the *Annales des Mines*, 5th series, vol. xx, p. 109.)
(*Continued from page* 72.)

## V.—WORKING OF BLAST-FURNACES.

1. *General Observations.*—Blast-furnaces are worked either for *foundry* or *forge* pig-metal; but this distinction is not absolute, as the same furnaces sometimes produce one and sometimes the other kind, according to their state of working. Indeed, this is generally the case in the greater number of those works whose object it is to obtain superior products: the greyest soughs (Nos. 1, 2, and 3) are classed as foundry metal, and the bright, mottled, and white soughs (Nos. 4, 5, and 6) are classed as forge metal. This is the case at Blaenavon, Pontypool, Ystalyfera, Yniscedwin, &c., in Wales; at Lowmoor and Bowling, in Yorkshire; and in a considerable number of the works of Staffordshire and Cleveland. But in addition to these *mixed* works, whose products are applicable both to casting and to the refinery, there are other works—and even entire districts—where the object is specially to make one single category of products: —in Wales, white forge-pig of inferior quality, for rails; in Scotland, a black foundry metal, for second fusion; in Staffordshire, forge pig-metal for making good merchant iron; and in the Cleveland district, a metal for making common wrought iron.

The great diversity between these products is partly due to the nature of the ores and of the fuel, but in a greater degree to the state of working, and to some extent even to the outlines of the furnaces. If in Scotland, where the ores are easy to treat, grey pig-metal is obtainable with any outline of furnace, and even with exceptionally large sections at the level of the twyers, this is no longer the case in Wales and Staffordshire, where the ores are less fusible,—and still less so in the Cleveland district, where the ores smelted are aluminous carbonates. In these cases it is necessary, about the region of fusion, to have the outlines narrower in proportion as the air is less hot and the pig-metal more grey.

Notwithstanding these differences, and those due to the relative proportions of the ore, fuel, and limestone adopted, the working of blast-furnaces is still very nearly the same, whether making foundry- or forge-pig; so that what follows may be applied indifferently to either case, with the exception of certain special points, which we shall take care to point out.

2. *Charging of the Blast-Furnaces; Composition of the Charges.*—The charging of blast-furnaces is effected by barrows or tip-waggons, and it is well known how much behind hand these arrangements are in England. Mr. Truran himself blames the carelessness with which this operation is carried out, and recommends weighing instead of measuring which is still in use in certain works. The amount of the

charges varies in different works and in different districts, and although it is generally admitted that a blast-furnace does not work well except with charges of a certain depth, there does not seem in reality to be much importance attached to it. What regulates the charges is the greater or less rapid working of the furnace. It is generally arranged that there shall be only four or five charges per hour at least where a distributing cone is adopted; for when the throat is open the charging is to a great extent continuous, for the furnace is kept continuously full. The extent of the charges should consequently be to some degree proportionate to the capacity of the furnaces; but in England they are generally rather small, particularly when compared with the charges made on the Continent. The volume of the fuel rarely exceeds 1¼ cubic yards when raw coal is charged (14 to 16 cwts.), or 2½ cubic yards when coke is used (16 cwts.); and this quantity is only attained in the largest of the Glasgow and of the Welsh furnaces.

In some works the ore and the limestone are mixed together, which is evidently a good arrangement; but in others the limestone is in the first place converted into quicklime. The English ores being all more or less argillaceous, the ordinary limestone suffices for fluxing them; but at Dowlais, where a large proportion of forge-cinders are treated, or a mixture of cinders and silicious hematites, a certain proportion of Coal-measure shales is added. As to the proportion of the limestone, that evidently depends on the nature of the ore and of the limestone, and on the purity of the fuel consumed. Per ton of pig-metal produced, the minimum and maximum range from 8 cwts. to 1 ton 2 cwts. In Staffordshire, where the ores principally treated are rich Coal-measure ironstones, the charge for hot air is generally:—per ton of forge-pig from 9 cwts. to 11 cwts; and per ton of foundry-pig from 10 cwts. to 12 cwts. In Wales, where the Coal-measure ores are poorer, the average with hot air, per ton of common pig-metal, is from 14 cwts. to 16 cwts. (or 10 cwts. of quicklime). But when the proportion of cinders and red hematite is considerable, the quantity of limestone does not exceed 10 cwts. On the other hand at Pontypool and Blaenavon, where cinders are never used, and the red hematite but rarely, it reaches for foundry-pig as high as from 18 cwts. to 1 ton; and with cold air to as much as 1 ton 2 cwts. This greater consumption of cold air is naturally surprising, since in general the converse is adopted, in order to avoid the reduction of the silica by the hot air. The opposite result arrived at in this case is due to the greater consumption of fuel from which results a greater abundance of slag, which has to be melted. The aluminous ores of Cleveland, lastly, require on an average 14 cwts. per ton of grey pig-metal; and the calcined black-bands of Scotland scarcely 8 cwts., although making black pig-metal, from their extreme richness, of from 55 to 60%.

3. *Management of Furnaces; State of Working.*—The labour required for attending on a blast-furnace, per 24 hours, is generally six men, including two fillers and two founders; some labourers are also required, in number varying according to the positions of the furnace, for removing the slags and pig-metal, and tramming the ore and fuel. In certain works the labour is less than this—thus at

Yniscedwin 8 men charge five blast-furnaces; but, on an average, the labour required for attending large blast-furnaces may be taken at from 8 to 10 men.

The special duties of the founders in English blast-furnace operations offer no special feature—except indeed in those districts where the furnace is worked with very lean raw coal (Swansea district), or very dry coal (Glasgow district), when the hearth becomes readily filled with incombustible coal dust, requiring a frequent cleaning out with the paddle or shovel. In order to aid the expulsion of this coal dust, many furnaces are worked with the breast open, by which a large jet of flame constantly escapes from under the tymp: in the anthracite furnaces, in particular, there is under the whole of the tymp an open space of from 3″ to 4″ high, through which the blast drives the incandescent dust. When on the other hand, however, no inconvenience is anticipated from this coal dust, a contrary arrangement is often adopted. The flow of the cinders is checked by rising the dam-plate 5″ or 6″ above the twyers, and the blast is thus forced through a layer of slag—thus transferring the combustion to the centre of the hearth and preserving the walls: this is particularly the case in furnaces that are worked with a high proportion of cinders.

Excepting those difficulties arising from this accumulation of coal-dust, the conducting of English blast-furnace operations is generally extremely simple, owing to the great fusibility and extremely reducible nature of the Coal-measure ores. The only ores at all refractory are those of the Cleveland district, and even they are not to be compared in this respect with the Tertiary ores of France; so that obstructions and too hot a state of working are rare and easily remedied. Indeed, on the contrary, too cold a working and consequently a corrosion of the walls of the hearth is rather to be dreaded in those districts where forge-cinders are used, and where the working is generally for white granular pig-metal. Indeed this accident is not rare in the Welsh works; but it may be effectually guarded against, besides changing the burden, and the temperature of the blast, by adopting cast-iron water-breasts, and frequently sprinkling the exterior surface of the hearth with water.

The state of working which is sought to be kept up, depends on the purity of the ores, and the uses for which the pig-metal is intended. The English ore being all more or less phosphorised (excepting the hematites or spathic irons), it is necessary generally to adopt a relatively hot working. In France, in the large works where coal is employed, it is possible regularly to work for white forge-iron, when the fusibility of the ores allows of it; and the pig-metal is sufficiently pure to make good bar-iron, notwithstanding a very rapid refining. In England, on the contrary, the proportion of phosphorus is such, that a slow and prolonged puddling will alone yield satisfactory products; so that the working of the blast-furnace must be hot, and the metal more or less grey. This is, in fact, the working generally adopted in the works of the Cleveland district, and of Staffordshire, and above all in those of Yorkshire (Lowmoor and Bowling). But it is in Scotland, particularly, that the working

is excessively hot, and that the iron is consequently quite black. This high temperature, together with a very basic condition, causes the greater part of the sulphur to pass into the slags, and probably also a notable fraction of the phosphorus. In Wales also—in those works making a superior quality iron—the object is also to make grey metal. In the case of rails only, and especially those of a very ordinary character (American rails), can a cold working be adopted. In this case, in consequence of the lower temperature and the large proportion of cinders, the produce is a granular white metal, slightly carburised, and refining rapidly in the puddling-furnace; but the manufactured iron produced evidently remains crude, hard, with little tenacity, and is only fit at the best for the making of common rails. Hence, with the exception of this special manufacture of the great Welsh works, the general tendency in England is to work for grey metal; a circumstance which partly explains the large consumption of the English blast-furnaces, compared with the greater number of those on the Continent.

The appearance of the slags depends, as we know, on the manner in which the furnace is worked. In the Welsh works, making pig-metal for rails, the slags are always black, vitreous, more or less blistered, and contain according to Truran an average of 12 or 14% of oxide of iron—but often as much as 15 or 20%. This author estimates the weight of iron thus annually lost in the Welsh works, at 250,000 tons; but it must be remembered, that the iron in these slags is principally derived from forge-cinders, and that their complete reduction is impossible.

In the works making grey pig, the slags are opaque, stony or crystalline, and of generally light tints. A very general colour in the English works, smelting the Coal-measure ores, is an olive yellow, which is very probably due to the sulphides of manganese, for it is always seen in those slags which are at once sulphurous and manganiferous. We have already referred to this point in the special description of the various districts. At present, it will suffice to recall to mind, that this same shade is likewise observed where the manganiferous, spathic and rather pyritous ore is smelted—at least as soon as the bases predominate in the bed of fusion.* The analyses which we have given show that in every case the manganese and the sulphur remain in great part in the slags, and that thus the manganese is really a corrective of the sulphur. The slags of the Cleveland district are stony and grey, like those of the ordinary French works, the olive shade being wanting—as the Liassic ores smelted in this district contain very little, if any, manganese.

In the English works the composition of the bed of fusion generally corresponds with that of a neutral silicate (RS), with sometimes even an excess of base. The proportion of silica is generally under 40%, and is sometimes as low as 30%. In consequense of this preponderance of bases, it is probable (according to Berthier's views in opposition to those of Karsten), that a portion of the phosphorus passes with the sulphur into the slags—doubtless under the form of

* The sulphurous and manganiferous slags of Bessèges have the same shade.

a phosphide of manganese or of calcium.* Of course it is difficult to prove this fact directly by analysis, but the experience of the Welsh works seems to prove it indirectly. We know that in refining the pig-iron the phosphorus is oxidised and passes in great part into the cinders, in the form of phosphate; but, as all the cinders are continually returned to the blast-furnace, it is clear that the phosphorus would always go on increasing in the bed of fusion, and consequently in the pig-metal, if the slags did not continually carry off a notable fraction of it. Now this *progressive* deterioration of the pig-metal has not been found to occur in Wales since the adoption of the use of cinders; so that the phosphorus must be carried away in the slags, and perhaps also to some extent with the gases.

(*To be continued.*)

# Abstracts and Reviews.

## THE BOARD OF TRADE RETURNS.

The "Accounts relating to Trade and Navigation of the United Kingdom, for the month ended 30th June, 1863, and six months ended 30th June, 1863," have been issued by the Statistical Department, Board of Trade.

IMPORTS.—The quantities and relative increase and decrease of the imports of metals, metallic ores, and mineral products, for the month and six months ended 30th June, have been as follows:—

| | Month ended 30th June. | | | Six Months ended 30th June. | | |
|---|---|---|---|---|---|---|
| | 1862. | 1863. | Increase (+) or Decrease (−). | 1862. | 1863. | Increase (+) or Decrease (−). |
| Brimstone ... ... cwt. | 101,399 | 50,633 | − 50,766 | 503,485 | 345,985 | −157,500 |
| Copper Ore ... ... tons | 8,978 | 7,664 | − 1,314 | 44,787 | 40,748 | − 4,039 |
| Copper Regulus ... ... " | 4,950 | 1,936 | − 3,014 | 17,067 | 11,679 | − 5,388 |
| Copper, unwrought and part wrought ... cwt. | 16,880 | 18,800 | + 1,920 | 127,940 | 101,940 | − 26,000 |
| Iron, in Bars, unwrought tons | 4,046 | 4,022 | − 24 | 8,479 | 10,597 | + 2,118 |
| Steel, unwrought ... " | 282 | 207 | − 75 | 2,125 | 768 | − 1,357 |
| Lead, Pig and Sheet ... " | 3,459 | 2,111 | − 1,348 | 10,482 | 11,083 | + 601 |
| Spelter or Zinc ... ... " | 2,337 | 3,888 | + 1,551 | 6,065 | 12,742 | + 6,677 |
| Tin, in Blocks, Ingots, Bars, or Slabs ... cwt. | 2,670 | 5,112 | + 2,442 | 35,908 | 19,339 | − 16,569 |
| Silver Ore... ... value in £ | 19,935 | 35,108 | + 15,173 | 143,279 | 174,331 | + 31,052 |
| Petroleum ... ...tuns | 2,614 | 5,391 | + 2,777 | 9,309 | 21,061 | + 11,752 |
| Quicksilver ... ... lbs. | — | — | — | 124,754 | 401,627 | +276,873 |

EXPORTS.—The quantities, declared value, and relative increase and decrease of the exports of metals, minerals, and metallurgical articles of British and Irish produce and manufactures, for the month and six months ended 30th June, have been as follows:—

* According to Durocher, phosphorus often exists in the slags in Sweden (Ann. des Mines, 5th Series, vol. ix, p. 475).

| | QUANTITIES. | | | | DECLARED VALUE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Month ended 30th June. | | Six Months ended 30th June. | | Month ended 30th June. | | | Six Months ended 30th June. | | |
| | 1862. | 1863. | 1862. | 1863. | 1862. | 1863. | Increase (+) or Decrease (−) | 1863. | 1863. | Increase (+) or Decrease (−) |
| | | | | | £ | £ | £ | £ | £ | £ |
| Alkali: Soda … … … cwt. | 156,013 | 154,498 | 987,564 | 1,040,786 | 67,648 | 63,391 | − 4,257 | 410,727 | 433,939 | + 23,212 |
| Coal, Cinders, and Culm … … tons | 624,151 | 712,572 | 3,815,079 | 3,880,841 | 279,407 | 308,796 | + 29,389 | 1,719,663 | 1,725,883 | + 6,220 |
| Iron, Pig and Puddled … … " | 36,532 | 41,323 | 220,241 | 230,068 | 98,587 | 110,731 | + 12,144 | 592,738 | 627,668 | + 34,930 |
| Iron, Bar, Angle, Bolt, and Rod… " | 24,445 | 25,711 | 142,831 | 157,383 | 177,637 | 192,418 | + 14,781 | 1,027,611 | 1,169,391 | + 141,780 |
| Iron, Railroad, of all sorts … " | 36,776 | 38,327 | 179,973 | 199,675 | 222,523 | 267,194 | + 44,671 | 1,261,459 | 1,420,156 | + 158,697 |
| Iron, Cast … … … … tons | 4,440 | 9,346 | 28,693 | 43,536 | 37,604 | 74,183 | + 36,579 | 257,973 | 364,302 | + 106,329 |
| Iron Hoops, Sheets, and Boiler Plates … … … " | 9,988 | 11,074 | 45,425 | 62,122 | 95,511 | 130,234 | + 34,723 | 447,059 | 704,198 | + 257,139 |
| Iron, wrought, of all sorts … " | 8,025 | 7,827 | 45,683 | 51,035 | 152,466 | 150,735 | − 1,731 | 904,015 | 965,051 | + 61,036 |
| Iron, old, for re-manufacture … " | 1,990 | 1,252 | 10,757 | 10,256 | 8,327 | 5,569 | − 2,758 | 42,820 | 38,733 | − 4,087 |
| Iron Steel, unwrought … … " | 2,468 | 2,081 | 12,654 | 13,034 | 78,546 | 68,013 | − 10,533 | 420,838 | 421,909 | + 1,071 |
| Copper, unwrought, in Ingots, Cakes, or Slabs … … cwt. | 7,671 | 31,274 | 45,232 | 188,221 | 37,071 | 142,386 | + 105,315 | 225,199 | 630,479 | + 405,280 |
| Copper, wrought or partly wrought, Bars, Rods, Bottoms, Pans, Plates, Sheets, and Nails; and mixed or Yellow Metal for Sheathing … " | 30,074 | 46,214 | 189,299 | 262,897 | 133,207 | 211,370 | + 78,163 | 888,916 | 1,198,345 | + 309,429 |
| Copper, wrought, of other sorts… " | 3,082 | 671 | 13,684 | 4,545 | 16,415 | 5,071 | − 11,344 | 83,782 | 28,160 | − 55,622 |
| Brass of all sorts … … " | 3,264 | 4,441 | 17,559 | 21,373 | 17,023 | 21,673 | + 4,650 | 95,012 | 106,225 | + 11,213 |
| Lead, Pig, Rolled, Sheet, Piping, Tubing, and Lead Shot tons | 5,136 | 8,017 | 16,590 | 19,024 | 106,969 | 64,746 | − 42,223 | 351,563 | 410,954 | + 60,391 |
| Lead Ore, Lead, Red and White, and Litharge of Lead … " | 831 | 400 | 4,515 | 3,166 | 18,694 | 9,480 | − 9,214 | 99,971 | 75,202 | − 24,769 |
| Salt … … … … … " | 61,705 | 47,570 | 312,563 | 309,986 | 33,259 | 23,537 | − 9,722 | 151,488 | 142,332 | − 9,156 |
| Tin, unwrought … … … cwt. | 4,378 | 7,985 | 38,195 | 36,518 | 25,318 | 47,354 | + 22,036 | 225,510 | 215,038 | − 10,472 |
| Tin Plates … … … … " | 86,370 | 84,328 | 519,162 | 545,108 | 105,731 | 97,485 | − 8,246 | 620,581 | 636,061 | + 15,480 |
| Zinc or Spelter, wrought or unwrought … … … " | 6,505 | 4,100 | 50,103 | 40,010 | 6,729 | 4,690 | − 2,039 | 49,291 | 39,864 | − 9,427 |
| | | | | £ | 1,718,672 | 1,999,056 | + 280,384 | 9,877,216 | 11,353,890 | +1,477,674 |

## M. MOISSENET ON THE CORNISH METHODS OF DRAWING STUFF.

*De l'Extraction dans les Mines du Cornwall. Puits inclinés et coudés.* Par M. L. Moissenet, Ingénieur des Mines. Paris: Dunod, Quai des Augustins, No. 49.

(*Continued from page* 96.)

### § 2. *Consumption and Effective Power of Engines. Labour in Filling and Landing.*

Coal.—Coal is the heaviest item in the cost of drawing, so that the Cornish engineers are justified in constructing (as they do) their engines with special regard to the economy of fuel. The general opinion is that, in this respect, a comparative perfection has been attained, and it is scarcely possible to controvert this view.

The effective power of an engine, with respect to the coal consumed, taking its working as a whole, is called its *duty*; which, as is well known, is calculated by the number of millions of pounds avoirdupois raised one foot high by the combustion of 1 cwt. of coal. In the case of pumping-engines, the duty is calculated by assuming the quantity of water to be equal to the volume described by the plunger-poles; and with winding-engines it is also arrived at by assuming the weight of the ore drawn to be equal to the number of skips or kibbles multiplied by the mean charge.

But this system of calculation easily leads to error by the general tendency that exists to exaggerate the estimate of this charge—so that it seems to me that the duty cannot be arrived at with any degree of certainty except by observations spread over a long period of working. The reader will judge of this by a comparison between the figures of the following table, which are founded on the details of yearly cost at several mines already particularised, and those which are given further on extracted from the *Reporter*.

Calculated Duty of Winding Engines.

| Mines. | Dates. | Number of Engines. | Mode of Drawing. | Duty. |
|---|---|---|---|---|
| A. Dolcoath .. | 1855 | 2 | Chains and kibbles | 5,674,854 |
| B. United-Mines .. | 1855 | 1 | Flat ropes and skips | 7,372,800 |
| C. Carnbrea .. | 1857 | 6 | Chains and kibbles | 3,665,454 |
| D. " .. | 1860 | 5 | Flat ropes and skips | 4,830,745 |
| E. Levant .. .. | 1861 | 1 | " " | 5,174,400 |
| F. " .. .. | July, 1858 | 1 | Wire ropes and skips | 2,217,600 |
| J. South Frances .. | Oct., 1861 | 1 | | 8,544,880 |
| | | | Average, including F and J .. .. | 5,343,650 |

Mr. W. Browne gives the following as the respective duties of the engines enumerated in the First Part, Section 3 (*Mining and Smelting Magazine*, vol. IV, p. 21), which it will be seen are very much higher, and which may fairly be set down as an exaggeration :—

| Engines. | Duty. |
|---|---|
| Edgecomb's .. .. .. .. .. .. | 27·4 millions. |
| Davis's .. .. .. .. .. .. | 25·7 „ |
| Pown's .. .. .. .. .. .. | 21·7 „ |
| Meredith's .. .. .. .. .. .. | 19·8 „ |
| Carthew's .. .. .. .. .. .. | 19·7 „ |
| Ray's .. .. .. .. .. .. | 17·2 „ |
| Trathen's .. .. .. .. .. .. | 10·1 „ |
| Average for July, 1857 .. .. | 18·8 „ |

The same Reporter gives the mean duty of twelve engines working in 1856 at 15·6. In comparison with these figures we may place a few analogous ones arrived at by other engineers in various localities.

Monsieur Ponson (*Exploitation de la houille*, T. III., pp. 355, 356) takes as the measure of the effective power, the number of kilogrammes raised 100 metres ($K^{100}$) by the combustion of one kilog. of coal. He has collected together the results of several observations which I reproduce—converting the result into duty :—

| Observers. | $K^{100}$. | Duty. |
|---|---|---|
| Tredgold— | | |
| Effective power considered as a maximum .. .. | 210 | 7,716,674 |
| Combes— | | |
| Experiments at Valenciennes previous to 1824 .. | 210 | 7,716,674 |
| Coal of inferior quality .. .. .. .. .. | 220 | 8,084,135 |
| Better fuel .. .. .. .. .. | 310 | 11,391,281 |
| | 320 | 11,758,742 |
| Godin— | | |
| Observation on 14 Belgian engines winding from an average depth of from 60 fms. to 200 fms. .. — Minimum .. | 127 | 4,666,751 |
| — Maximum .. | 283 | 10,399,138 |
| — Average .. | 180 | 6,614,292 |

The average of the 14 Belgian engines is a little greater than the duty of 5,343,650 deduced from the examples taken in the table given above, which would be equal to 143 $K^{100}$ against 180 $K^{100}$; but if we adopt the duties given by the *Reporter*, we should have an average of 18·8 millions—more than 500 $K^{100}$—and Edgecomb's engine would reach 750 $K^{100}$. If such results were really attained, every country should at once hasten to provide themselves with engines from Cornwall! Fortunately it is not necessary to put forward such exaggerated statements in order to prove the intrinsic merits of the Cornish engine as an economical motive power. I estimate the average duty of the Cornish winding-engines at 5·5 millions duty = to 150 $K^{100}$.

If we compare the conditions that obtain in the inclined and elbowed shafts, where chains are constantly used, where there is frequently an intermittent working, and where the drawing is from various depths—with the conditions of winding in coal mines, in Belgium or elsewhere, it will be readily admitted that the 150 $K^{100}$ ($5\frac{1}{2}$ millions duty) shown by the Cornish engines, demonstrate their economical superiority, even taking into account the quality of the Welsh coal which they employ.

But however excellent the motive-engines may be—and they certainly are good—the definite results, in the quantity of coal burned, may yet be extremely unsatisfactory. And this is assuredly the case, if we compare

the duty attained by the pumping-engines in the same county. We shall certainly not be very far from the truth in taking 55 millions as the average duty of the latter, against 5½ millions for winding-engines ; so that the lifting of a given weight of water only requires *one-tenth* of the coal required to lift the same weight of ore.

TALLOW, OIL, HEMP, &c.—The consumption of accessory materials varies considerably according to the state of repair of the engines. These materials consist of hemp, engine-shag, &c., used for packing the pistons, valves, and joints ; tallow, oil, and patent grease for lubricating the various parts of the engine, together with the out-of-door apparatus, and the axles of the skips ; and lastly, candles for the use of the night cores.

With the prices of materials and the mode of working adopted in Cornwall, the cost of these represents on an average from 10 to 12 °/₀ of that of the coal. The following table, referring to the six Carn Brea engines, may suffice to give an idea of the influence of the condition of the engines, and of their discontinuity of working ; it will be seen that the suspension of the working diminishes but little the monthly cost, which is far from being reduced in proportion to the stoppages.

CONSUMPTION OF SIX WINDING ENGINES AT CARN BREA MINES, IN 1857.

NOTE.—Barncoose engine only worked nine months ; and the boiler of Dobree's supplied the steam for sample crusher.

| Name of Engine ... ... ... ... | Barncoose. | | | | Dobree's. | | | | Highburrow. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter of Cylinder and Length of Stroke ... ... ... ... | 18″—4′ | | | | 18″—4′ | | | | 24″—7½′ | | | |
| Type of Engine, and H.P. ... ... | Double, 19 H.P. | | | | Double, 19 H.P. | | | | Double, 34 H.P. | | | |
| Duration of Working ... ... ... | Continuous. | | | | 16 hours in 24. | | | | 16 hours. | | | |
| Materials consumed— s. d. | | £ | s. | d. | | £ | s. | d. | | £ | s. | d. |
| Coal ... ... @ 15 6 per ton ... | 135 = | 104 | 12 | 6 | 172½ = | 133 | 13 | 9 | 165 = | 127 | 17 | 6 |
| Oil ... ... @ 4 8 „ gallon | 6 = | 1 | 8 | 0 | 8½ = | 1 | 19 | 8 | 11½ = | 2 | 13 | 8 |
| Tallow ... ... @ 60 0 „ cwt. ... | 2¼ = | 6 | 15 | 0 | 2¼ = | 6 | 15 | 0 | 3¼ = | 9 | 15 | 0 |
| Hemp and Shag @ 0 3 „ lb. ... | 92 = | 1 | 3 | 0 | 110 = | 1 | 7 | 6 | 211 = | 2 | 12 | 9 |
| Candles ... ... @ 0 7 „ lb. ... | 74 = | 2 | 3 | 2 | 22 = | 0 | 12 | 10 | 88 = | 2 | 11 | 4 |
| Total cost per engine ... | | 116 | 1 | 8 | | 144 | 8 | 9 | | 145 | 10 | 3 |

| Name of Engine ... ... ... ... | Old Sump. | | | | Barker's. | | | | Druid. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter of Cylinder and Lenght of Stroke ... ... ... ... | 18″—4′ | | | | 24″—5′ | | | | 13″ & 30″—4½′ | | | |
| Type of Engine, and H.P. ... ... ... | Double, 19 H.P. | | | | Single, 27 H.P. | | | | Sims Combined, 33 H.P. | | | |
| Duration of Working ... ... ... | Continuous. | | | | 16 hours. | | | | 12 hours. | | | |
| Materials consumed— s. d. | | £ | s. | d. | | £ | s. | d. | | £ | s. | d. |
| Coal ... ... @ 15 6 per ton ... | 205 = | 158 | 17 | 6 | 183 = | 141 | 16 | 6 | 130 = | 100 | 15 | 0 |
| Oil ... ... @ 4 8 „ gallon | 12 = | 2 | 16 | 0 | 10½ = | 2 | 9 | 0 | 9½ = | 2 | 4 | 4 |
| Tallow ... ... @ 60 0 „ cwt. | 3½ = | 10 | 10 | 0 | 3¼ = | 9 | 15 | 0 | 2¾ = | 8 | 5 | 0 |
| Hemp and Shag @ 0 3 „ lb. | 257 = | 3 | 4 | 3 | 195 = | 2 | 8 | 6 | 54 = | 0 | 13 | 6 |
| Candles ... ... @ 0 7 „ lb. | 93 = | 2 | 14 | 3 | 70 = | 2 | 0 | 10 | 41 = | 1 | 3 | 11 |
| Total cost per engine ... | | 178 | 2 | 0 | | 158 | 9 | 10 | | 113 | 1 | 9 |

This shows a total consumption for the year for the six engines, of—

| | | £ | s. | d. |
|---|---|---|---|---|
| Coal .. .. .. .. | 990 tons | 767 | 0 | 0 |
| Oil .. .. .. .. | 58 gallons | 13 | 12 | 0 |
| Tallow .. .. .. .. | 17¼ cwts. | 52 | 3 | 0 |
| Hemp and shag .. .. .. | 920 lbs. | 11 | 10 | 0 |
| Candles .. .. .. .. | 389 „ | 11 | 7 | 0 |
| Total .. .. .. .. | | 855 | 12 | 0 |

ENGINEERS.—The persons connected with the working of an engine are:—

An engineer;
A working engineer;
An engine-man;
Tenders, wheeling coal and ashes.

All are paid by the month; the engineers being classed among the agents, and the others among the surface labourers. The engine-men entail the greatest amount of cost, and are alone included in the details of the cost of drawing: their wages vary with the locality and the work they have to do, but it always includes the attendance on the boilers as well as on the engine itself.

Where the working is continuous it is necessary to have cores of 8 hours as in the case of the miners, or three men for each engine. If the working is for 16 hours out of the 24, two men suffice; and if the working is for 12 hours only, whether with a whim or a stamping-engine, there is only one engineer at rather higher wages. The pumping engines, which work slowly and continuously, require less attention than winding engines, and the engine-men are consequently paid less. The ordinary wages of a working engineer is 3*l.* per month—but it varies from 2*l.* 15*s.* to 3*l.* 10*s.*, exclusive of extra work which is occasionally paid for cleaning the engine and boilers: this payment is about 6*s.* for an engine and 7*s.* for a boiler.

The system of task-work, which is so admirably organised in the Cornish mines, has sometimes been applied to the working of engines; and the following example of this system applied to the two principal shafts at Dolcoath may be regarded with interest.

*Account of drawing done by contract, during the month of* JULY, 1858—*being a 5-weeks month of* 30 *working days.—Coal paid for at* 12*s. per ton, and candles at* 9*d. per lb.*

GOZZAN WHIM.

Average depth, 270 fms.
Price per 100 kibbles, 16*s.*

| | £ | s. | d. |
|---|---|---|---|
| Drawn 3,179 kibbles with extra work .. .. | 25 | 19 | 1 |
| Deduct: coal 24 tons, candles 10 lbs. .. .. | 14 | 15 | 6 |
| Balance for 3 men .. | 11 | 3 | 7 |
| Wages per man .. | 3 | 14 | 6½ |

OLD SUMP WHIM.

Average depth, 260 fms.
Price per 100 kibbles, 15*s.* 6*d.*

| | £ | s. | d. |
|---|---|---|---|
| Drawn 3,528 kibbles with extra work .. .. | 27 | 13 | 10 |
| Deduct: coal 28½ tons, candles 10 lbs... .. | 17 | 9 | 6 |
| Balance for 3 men .. | 10 | 4 | 4 |
| Wages per man .. | 3 | 8 | 1¼ |

For the year 1855, at the same mine, the total of 226*l.* 16*s.* at the two shafts represents an average wages of 3*l.* 3*s.* per man per month. The tenders, wheeling coal and ashes, get from 1*l.* to 1*l.* 15*s.* per month, and one generally suffices for four or five engines; when, however, the working at Dolcoath was very brisk, as in 1858, there were three tenders employed, at a monthly cost of 4*l.* 10*s.*, wheeling from 17 engine-men. The wages of the engine-men, on large mines, may be estimated at from 7 to 8°/₀; and several of the largest mines likewise employ a working engineer, at from 4*l.* to 5*l.* per month, who attends to the more simple and urgent repairs of the engines and machinery;—who in fact acts as a kind of resident foreman under the direction of the engineer of the mine. Sometimes this post is occupied by one of the under-ground agents; indeed I have met several men who united both professions with equal skill, and who seemed to me by no means the least efficient as engineers, even in this county where speciality is the base of all organisation.

One of the most remarkable of these specialities, is the class of engi-

neers, who by their magnificent pumping engines have established such a wide-spread reputation. They have, almost all, a large experience and an extensive practice; and several have, joined to this, a sound theoretical knowledge. Their position, with respect to the mines, may be compared to that of architects in a town; they live in the principal centres, and group round them a business extending many miles. They are usually paid at the rate of 10*s.* per month per engine. If there is but one engine, they pay one or two visits per month; but if there are several their visits are more frequent. I know, however, the case of two mines, at each of which the engineer is paid 4*l.* per month, although in the one there are 12 old engines to attend to, while in the other there are but four comparatively new ones;* so that the payment of engineers by no means follows any very fixed rule. Still it is not an item to be neglected in estimating the cost of drawing, for it may amount to as much as 1*l.* or 2*l.* per month, for engineer and working engineer—and would thus equal from 8 to 17°/₀ of the wages of the engine-men. Adding this to the cost of the engine-men, the whole cost under this head will be increased from 15 to 25°/₀.

The labour at the engine, when the drawing is continuous, is a dead cost, independent of the conditions of working; but of course it is the heavier, per ton drawn, in proportion as the production is less. I have collected together in the following table the cost per month at the several engines I have already mentioned—discriminating the proportion of cost due to the consumption of materials, and that due to the labour of the engine-men.

MONTHLY COST OF WINDING-ENGINES.—MATERIALS AND LABOUR.

| Name of Mine .. | *Dolcoath.* | *United Mines.* | *Levant.* | *Carn Brea.* | *South Frances.* |
|---|---|---|---|---|---|
| No. of Engines .. | Avge. of 2. | 1. | 1. | Avge. of 5. | 1. |
| Date .. .. | 1855. | 1855. | 1862. | 1860. | Oct. 1861. |
| Working .. .. | Continuous | | Discontinuous. | | |
| | £ *s.* *d.* | £ *s.* *d.* | £ *s.* *d.* | £ *s.* *d.* | £ *s.* *d.* |
| Coal .. .. | 19 6 6 | 28 0 0 | 27 0 0 | 13 4 9 | 8 9 0 |
| Tallow, hemp, &c. | 1 3 0 | 8 0 0 | 2 0 0 | 1 5 4 | 1 10 0 |
| Engine-men .. | 9 9 0 | 9 0 0 | 6 10 0 | 4 10 4 | 7 10 0 |
| Totals .. | 29 18 6 | 45 0 0 | 35 10 0 | 19 0 5 | 17 9 0 |
| | Ratio (or percentage) of Total Cost. | | | | |
| Coal .. .. | 64·6 | 62·2 | 76·1 | 69·7 | 48·4 |
| Tallow, hemp, &c. | 3·8 | 17·8 | 5·5 | 6·6 | 8·6 |
| Engine-men .. | 31·6 | 20·0 | 18·4 | 23·7 | 43·0 |
| Totals .. | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |

FILLING AND LANDING.—Whatever system of drawing may be adopted the filling is always by hand; the filler loading from ten to twelve tons of ore in 8 hours, according to the conditions under which he works: the maximum of from 14 to 15 tons is rarely attained.

With kibbles, only one man is employed; but with skips, whose capacity is about double, two fillers are employed in a core. This number cannot be increased in consequence of the difficulty there would be in more

* The Cornish engineers are paid, for the designs and drawings of engines, at the rate of one guinea per inch of cylinder; and at a somewhat similar rate for designs for stamps, crushers, and other mining machinery.

than this number filling at one time at the mouth of the skip; so that the production of a shaft is limited to the quantity that can be filled by six men in 24 hours—that is, 60 or 75 tons. If the circumstances require it, it is no doubt possible to employ eight men, in 4 cores of 6 hours, and so fill from 80 to 95 tons per day. We shall refer further on the influence which the rate of drawing, and the depth of the shaft, have with respect to the quota of stuff drawn; but it will be obvious that if the first is low, and the second very considerable, the filler has more rest than he requires, and that, consequently, the work he performs is diminished.

The cost of filling in kibbles or skips is the same; but the landing of skips is less fatiguing, so that although they come up oftener, a single man at the surface is, under ordinary circumstances, sufficient to occupy two men filling under ground; while with kibbles there must be as many landers as fillers. Against this we may set the fact, that the lander with kibbles has generally time to empty his waggon on the floors between the arrival of two kibbles; while in landing skips this is rarely possible, and a trammer is generally required. Of course the question of surface tramming is one that cannot properly be entered upon under the head of drawing; but still it is well to consider every question that bears upon the complete utilisation of the time and labour of the lander. On the whole it seems, that the total cost per ton of filling and landing is about the same under both conditions. The average wages of men thus employed are 3*l.* for fillers, and from 2*l.* to 2*l.* 10*s.* for landers.

Among the particulars of drawing cost of the various mines already given—from Dolcoath to South Frances—it is only in certain of them that the cost of filling and landing is separated; in those where the division is not made, I have estimated their respective proportions from the data afforded in those mines where the items are kept distinct; and I have collected and classified the whole in the following table:—

Cost of Filling and Landing.

| Mines and Work. | No. per Shaft. | Wages per Man per Month. | Hours in Core. | Tons drawn— Per Day. | Tons drawn— Per Man per Core. | Cost per Ton. | Total Cost of Labour including Engine-men. Per Ton drawn. | Per Ton per 100 fms. | Per-centage of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | | *s.* *d.* | | | Tons. Cwts. | *d.* | *d.* | *d.* | |
| Dolcoath— | | | | | | | | | |
| Fillers .. | 3 | 60 0 | 8 | 33½ | 11 4 | 4·76 | 7·46 | 2·97 | 32·4 |
| Landers .. | 3 | 51 0 | 8 | | 11 4 | | | | |
| United Mines— | | | | | | | | | |
| Fillers .. | 6 | 60 0 | 8 | 64 | 10 14 | 4·2 | 5·55 | 2·31 | 29·6 |
| Landers .. | 4 | 50 0 | 12 | | 16 0 | | | | |
| Levant— | | | | | | | | | |
| Fillers .. | 4 | 67 0 | 8 | 56 | 14 0 | 4·28 | 5·39 | 2·83 | 29·3 |
| Landers .. | 2 | 55 6 | 8 | | 28 0 | | | | |
| 2 trammers .. | — | — | — | — | — | — | — | — | — |
| South Frances— | | | | | | | | | |
| Fillers .. | 4 | 60 0 | 8 | 40 | 10 0 | 3·84 | 5·63 | 4·47 | 60·0* |
| Landers .. | 2 | 40 0 | 8 | | 20 0 | | | | |
| Carn Brea .. | — | — | — | — | — | 4·95 | 7·22 | 4·3 | 44·0* |

* At South Frances and Carn Brea mines the cost of drawing does not include the maintenance of the shaft.

We thus see that the filling and landing costs from *4d.* to *5d.* per ton, and that the total cost of labour ranged from *5½d.* to *7¾d.*, depending principally on the production, and the greater or less activity of the working. This shows an average of *6d.* per ton, which is the sum usually given as the labour cost of drawing.

(*To be continued.*)

## ON THE STATE OF CARBON IN CAST-IRON.

Mr. William Crossley, F.C.S., in a communication to the *Chemical News*, suggests a new theory as to the state in which carbon exists in cast-iron. He commences by stating the theory at present generally held—in support of which he quotes passages from Mr. Abel and Professor Miller—which is, that the carbon exists in two distinct states:—*combined*, as a fusible carbide, and *uncombined* (disseminated through the mass of the iron), as graphite, or free carbon; the notion being, that according as the carbide or the graphite predominates, the iron is white or grey—the *white* containing much *carbide* but little graphite, and the *grey* much *graphite* but little carbide.

In Mr. Crossley's opinion these views have no foundation. Having had frequent occasions to examine samples of grey iron with a lens, he has never yet been able to see the scales of graphite referred to by some writers; and he believes that if grey iron were carefully examined, it would be found to consist—not of iron and graphite, but of an aggregation of crystals, consisting of carbon and iron chemically combined.

Assuming that the ordinary theory be true, and that the carbon exists in grey iron in the form of graphite, the following difficulties at once present themselves. How is it that grey iron is more fluid than white iron, when in the former (on this assumption), we have almost pure iron (which is very difficult to make fluid at all), merely mixed with carbon; while in white iron, on the contrary, the carbon is chemically combined; it being well known that the carbide of iron is more fusible than iron free from carbon? How is it also, that the graphite does not separate when the iron is in a fluid state—the graphite itself being infusible and of much less specific gravity than the iron? Mr. Crossley is aware that these difficulties are supposed to be answered by suggesting—(1) that the iron is capable of dissolving graphite when it melts, and again liberating this graphite when it cools; and—(2) that a carbide of iron is formed, when the iron melts, which is again decomposed on cooling. He thinks, however, that neither of these explanations is tenable; nor does he believe that the carbon exists at all in two states—one combined and the other uncombined.

As to the *first* suggestion—that the graphite is converted into a fluid carbide when the iron melts—he draws attention to the fact, that iron made under similar conditions, contains about the same proportion of carbon, whether grey or white; for instance, the carbon determined by combustion in three samples of grey, and three of white iron, gave the following results:—

| | Grey. | Average. | White. | Average. |
|---|---|---|---|---|
| Carbon .. | 3·94 | 3·91 per cent. | = 3·86 | = 3·87 per cent. |
| " .. | 3·92 | | = 3·85 | |
| " .. | 3·88 | | = 3·95 | |
| Difference .. .. .. | | | ·04 per cent. | |

Now, if these irons are melted, the grey (on this suggestion) is converted into a carbide—which the white has always been; so that we have two irons in a fluid state, both containing the same quantity of carbon, yet one

more fluid than the other. How is it that, on cooling and solidifying, the one separates the carbon as graphite, and the other does not ?

As to the second suggestion—that a carbide of iron is formed in melting, which is again decomposed on cooling—Mr. Crossley thinks that this is even more untenable than the other. Faraday has shown that iron is capable of combining with 6 % of carbon ; but very few commercial irons contain more than 4 % ; and if a proportion of this be uncombined, how is it that the iron is dissolved without, at the same time, combining with it ?

After further illustrating the difficulties of the generally received hypotheses, Mr. Crossley proceeds to state his own theory—which is, that there are two carbides of iron, the one grey and soft, and the other white and hard, the grey being a higher carbide than the white ; and that the different varieties of cast-iron are varying mixtures of these two carbides with metallic iron. By this theory he considers it easy to account for the non-separation of the graphite when grey iron is melted—the grey appearance being due not, to the presence of graphite, but to that of the grey fusible carbide referred to. He is aware, of course, that graphite does separate when grey is melted ; but then this only occurs in very small quantities, which are easily accounted for from the decomposition of the grey carbide, and in fact illustrate one of the most remarkable properties of grey iron—its instability, of which he gives some illustrations. For the purpose of testing some of these views by experiment, Mr. Crossley broke four pieces from a pig of very grey iron, put three of them in separate plumbago crucibles, each covered and coated with fire-clay, and then put them into a wind furnace, which was gradually urged to a white heat. The fire was then allowed to burn out, and one of the crucibles removed, which was labelled No. 1. The fire was again lighted and urged, and again allowed to cool, and another crucible was then removed, and labelled No. 2. The third was again treated in a similar manner, and then labelled No. 3. The object in melting in carbon crucibles was to prevent access of air to the melted iron, or that if any air did succeed in passing through it would be deoxidised by the carbon.

The button of iron in No. 1 crucible was coated on the outside with "keech," or kish, as the graphite is generally called. When the button was split, the fracture showed it to be "No. 3" iron.

The button of iron from No. 2 crucible had less graphite on the outside, and judging from the fracture, it might be called "No. 4" iron.

The button from No. 3 crucible was "mottled," or "No. 5" iron, and was quite free from graphite on the outside.

Thus, by melting No. 1 once, "No. 3" iron was formed ; melting a second time, "No. 4" iron ; and a third time, "No. 5" iron.

Mr. Crossley explains these changes by supposing that in the *first* melting a small quantity of the grey iron had been decomposed, and a little graphite liberated ; that in the *second* melting more graphite separated, but the graphite liberated from the first melting had again united to form the white carbide ; and that in the *third* melting, all the graphite which had previously separated again combined, and "mottled" iron resulted.

Mr. Crossley afterwards determined the quantity of carbon in the buttons of iron, and he considers that the results obtained appear to confirm his theory. They were as follows :—

| | | | |
|---|---|---|---|
| Iron before melting, carbon | = | 3·93 | per cent. |
| 1st melting .. .. | = | 3·86 | " |
| 2nd " .. .. | = | 3·90 | " |
| 3rd " .. .. | = | 3·95 | " |

The low results obtained in No. 1 he accounts for by the graphite liberated in melting : in No. 3, this being again combined, the discrepancy is not seen.

## IRON SMELTING BY GAS.

In the year 1856 Dr. Gurlt, of Bonn, suggested in a memoir called, "*Die Roheisen-Erzeugung mit Gasen*" (the making of pig-iron with gases), and also under the title: "*Sur la fabrication de la fonte et du fer au moyen des gaz,*" the exclusive employment of gas instead of solid fuel, for the making of iron—both for the reduction of the ores, and for the smelting—as a process which he considered might be profitably adopted. Attracted by this suggestion, Senor Justino Delpon introduced this new smelting process into Spain under peculiarly favourable circumstances, and he has carried it on successfully for many years at the Santa Ana de Bolueta works near Bilboa.

The iron-ore treated at Bolueta belongs to the hippurite limestone of the chalk formation, and is obtained at San Juan de Sommorostro, in the neighbourhood of Bilboa. It is a very pure brown hematite containing about 7°/₀ of water, and 65°/₀ of iron. The ore is so easily fusible, and contains so little matter convertible into slag, that it cannot be smelted entirely alone in a blast furnace, but on that account it is the more suitable for being reduced in the gas-furnace, and then worked directly in the forge.

The furnaces, at present in use at Bolueta, are constructed on the plan proposed in Dr. Gurlt's memoir, and, in the course of time, have been subjected to but trifling and immaterial alterations. Each consists essentially of a furnace-shaft, which is charged at the throat with the ore to be reduced, and is emptied from time to time at the bottom. On each side of the furnace is a gas-generator, in which reducing gases (carbonic oxide, hydrogen, sulphuretted hydrogen) are evolved from oak and beech charcoal by means of a blast: these, entering the furnace-shaft in a state of incandescence, and rising up in it, completely permeate the charge. These effect the reduction of the ore at a strong red heat, and bring the oxide of iron into a spongy state (esponja), in which state the pieces of ore retain their original form, only having become porous from the loss of oxygen and water. This spongy iron is drawn out from time to time, while hot, into small iron waggons, and is immediately covered with fine charcoal till it is cooled, in order to prevent re-oxidation from contact with the air. At Bolueta 3 tons 12 cwts. of ore, with 18¾ cwts. of charcoal, are daily treated in the furnace in three charges, furnishing 2 tons 7 cwts. of spongy iron. This spongy iron is now treated in a Catalan forge, in charges of 1¼ cwts. each, which furnishes 1 cwt. of soft iron with a consumption of a like quantity of charcoal. Thus we see that by these two processes 5¼ cwts. of raw ore, with 3½ cwts. of charcoal, furnish 2 cwts. of merchantable iron.

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## CORRELATION OF THE MECHANICAL AND CHEMICAL FORCES.

In the Bakerian lecture for the Royal Society, Mr. H. C. Sorby, F.R.S., has contributed a most suggestive memoir, "On the Direct Correlation of Mechanical and Chemical Forces." He opens by stating that, in pursuing his investigations in chemical and physical geology, he had been greatly perplexed by a class of facts which pointed both to a mechanical and chemical origin. These he at first attributed to one or the other action—then to the two combined—but without arriving, by either hypothesis, at a satisfactory explanation; and at length facts turned up showing direct correlation, and proving that mechanical force had been resolved into chemical action, in the same way as it may be resolved, under certain circumstances, into heat, electricity, or any other modification of force.

No facts had hitherto been observed proving a *direct* production of chemical action from mechanical force; although that such a result would be extremely probable is evident from the fact that the converse is true—

that is, that mechanical force can be produced by chemical action. In this paper Mr. Sorby proves that such is really the fact, and that in some cases even the actual mechanical equivalent of the chemical force may be determined.

It is a well-known fact that the fusing-point of various substances is influenced by pressure. Substances which *expand by fusion* have their point of fusion *raised* by mechanical pressure—that is to say, since mechanical force must be overcome in melting, the tendency to melt must be increased by heat before that opposition can be overcome; and the pressure required to keep them solid at any temperature above their natural point of fusion may be looked upon as the mechanical representative of the force with which they tend to fuse at that temperature. Water, on the contrary, which *expands in freezing*, has its point of fusion *lowered* by pressure—that is to say, since mechanical force must be overcome in crystallising, crystallisation will not take place unless the force of crystalline polarity be increased by reducing the temperature.

Now, Mr. Sorby finds that similar principles hold true with respect to the solubility of salts in water: if, when they dissolve, the total *bulk increases*, pressure *reduces* their solubility; whereas, if the *bulk decreases*, pressure makes them *more* soluble—that is to say, solution or crystallisation is impeded by pressure according as mechanical force must be overcome in dissolving or crystallising.

It would exceed our space to refer to Mr. Sorby's experiment, and we shall consequently confine ourselves to giving a summary of his conclusions. He considers the solubility of a salt in water to result from a kind of affinity which decreases in force as the amount of salt in solution increases. This affinity is opposed by the crystalline polarity of the salt; and when the two forces are equal the solution is exactly saturated. As is well known, a change of temperature alters this equilibrium;—and mechanical pressure, also, according to Mr. Sorby, relatively increases one or other of these opposing forces, according to the mechanical relations of the salt in dissolving. Thus, with chloride of sodium, the extra quantity of salt dissolved under pressure varies directly with such pressure—in the same manner as the fusing-point of ice is reduced; while with sal-ammoniac (the only salt known to occupy more space in solution than when crystallised) the solubility is decreased by pressure. As this last result is the reverse of what ensues from an elevation of temperature, it cannot be due to any heat generated by pressure, but must be the direct consequence of pressure itself.

As an example of the determination of the mechanical equivalent of this chemical result we may give the results got at in the case of this salt (sal-ammoniac). Calculating from an experiment where pressure was 164 atmospheres, which gave a decreased solubility of 1·045 °/$_0$ of the whole salt in solution, a pressure of 100 atmospheres would cause ·637 °/$_0$ less to bo dissolved than is soluble at 20° C. without pressure, and the pressure requisite to reduce the solubility to the extent of 1 °/$_0$ would be 157 atmospheres. Expressing this fact in other words, we may say that a pressure of 157 atmospheres is the mechanical force with which the salt tends to dissolve in a solution containing 1 °/$_0$ less than can dissolve at the same temperature without pressure, because the two forces exactly counterbalance one another. In a still more dilute solution the force would, of course, be still greater, in accordance with the fact of a greater pressure being necessary to prevent the salt from being dissolved. Supposing then that we had a solution a trifle more dilute than that just named, and in such indefinitely large quantity that a cubic inch of the salt could dissolve in it, and yet produce no sensible change in its strength—so that from the first to the last it might be considered to dissolve under a pressure of 157 atmospheres;—and also supposing that it was rigidly enclosed on all sides

but one, so that the whole expansion must take place in one direction over an area of one square inch; since, on dissolving, there is an increase in bulk from 100 to 115·78—the solution of this cubic inch would, as it were, raise 2,355 lbs. through the space of ·1578 inch. This is mechanically the same as 371½ lbs. raised one foot, or, the specific gravity of the salt being 1·53, the same as 171 times the weight of the salt itself raised 1 metre. Since it involves no arbitrary unit but the metre, I shall adopt the last expression as the measure of the total amount of mechanical work done by the solution of salts which expands in dissolving, and which may conversely be looked upon as the measure of the mechanical force rendered latent, and, as it were, expended in the act of crystallisation, when crystals are deposited. The value of this mechanical equivalent of course varies with the strength of the solution, as already remarked.

In the case of salts which occupy less space when dissolved than when solid, pressure, like increased temperature, causes them to be more soluble—mechanical force appearing to be lost when they dissolve, and being, as it were, expended in giving rise to solution. When water thus containing more of a salt than could otherwise be dissolved at the same temperature, is just saturated under any given pressure, the amount of pressure represents the amount of crystalline polarity tending to cause the salt to be deposited in a crystalline form, but which is exactly counterbalanced by that pressure. Examining, on this principle, the six following salts—chloride of sodium, sulphate of copper, ferridcyanide of potassium, sulphate of potash, ferrocyanide of potassium, and water—Mr. Sorby determines (among other results), (*a*) the increased solubility that would be produced by a pressure of 100 atmospheres, the total amount of salt dissolved without pressure being 100; and (*b*) the mechanical force set free, when the respective salts are crystallised from a solution containing 1 °/₀ more than would be dissolved without pressure, as measured by the number of times, of its own weight, which any unit of the various salts could raise to the height of 1 metre in the act of crystallising. These are as follows:—

| | (*a*) | (*b*) | | (*a*) | (*b*) |
|---|---|---|---|---|---|
| Chloride of sodium .. | ·419 | 157 | Sulphate of potash .. | 2·914 | 42 |
| Sulphate of copper .. | 3·183 | 7 | Ferrocyanide of potassium .. .. | 2·485 | 20 |
| Ferridcyanide of potassium .. .. | ·335 | 42 | Water .. .. .. | ·991 | 106 |

With regard to column (*b*), the amount of mechanical force here given also, conversely, represents the amount of force which becomes latent in the act of solution; and in the case of a still more supersaturated solution it would be greater, and *vice versâ*, in accordance with the fact of the increased solubility varying with the pressure.

On comparing these various salts, it will be seen that their properties vary very considerably; for, under the same pressure, the extra quantity of sulphate of copper dissolved is nearly ten times that of ferridcyanide of potassium. The mechanical equivalents also vary even more, being (for chloride of sodium) about 22½ times as great as for sulphate of copper. On the contrary, the mechanical equivalents of ferridcyanide of potassium and sulphate of potash are the same; but, under equal pressures, the extra quantity of the latter dissolved is nearly nine times as great, owing to the difference in the amount of expansion in crystallising. This latter is, however, nearly the same for water and ferrocyanide of potassium, whilst, under the same pressure, the extra quantities of that salt dissolved is 2½ times that of ice, in consequence of the much greater mechanical equivalent of the ice. It appears therefore that we may provisionally conclude that the increased solubility due to pressure varies *directly with the change of volume and inversely with the mechanical equivalent* of the force of crystalline polarity.

The facts show that there is a direct correlation between mechanical force and the forces of crystallisation and solution. Some chemists consider the latter an instance of real combination; and it cannot be denied that it represents some modification of chemical affinity—or is at all events most closely allied to it. In comparison with some kinds of affinity it is no doubt weak; but still it has sometimes, as shown, a considerable mechanical equivalent, even when nearly counterbalanced by an opposing force. Mr. Sorby has, indeed, succeeded in obtaining results which show that pressure influences undoubtedly chemical changes taking place slowly, and therefore probably due to weak, or nearly counterbalanced, affinities. The results arrived at in two of these cases are given as follows:—

When Witherite is inclosed in a tube with a strong solution of protochloride of iron, there is a slow decomposition into chloride of barium (which is dissolved) and carbonate of iron (which remains attached to the Witherite). In this change there is an *increase* in volume equal to about 10·7 °/₀ of the Witherite altered, so that, under pressure, mechanical force must be overcome. For four months this was kept under an average pressure of 80 atmospheres, when the chemical change was 21·7 °/₀ *less* than when there had been no pressure—thus clearly showing that pressure had, as it were, diminished the force of chemical affinity. If one cubic inch had been thus altered, it would have overcome a mechanical force equal to that required to raise 1,200 lbs. through a space of ·107 inch, or raising 21 times its own weight to a height of 1 metre. If no mechanical force had to be overcome, 1·278 cubic inches would, under the same circumstances, have been altered. So that (the force which gives rise to a purely chemical change taking place at a particular rate) = (that which gives rise to this chemical effect taking place at ·783 of that rate) + (the mechanical effect equal to the force required to raise, in the same space of time, 34·87 times the weight of the Withreite altered to the height of 1 metre). Assuming that the power of chemical force varies as the rate at which it gives rise to chemical change, we might conclude that this mechanical force is equal to ·217 of the chemical force, and that the whole energy of the chemical action was equal to the mechanical power required to raise (in the same time) 160 times the weight of the Witherite altered to the height of 1 metre. If these principles were correct, a pressure of more than 370 atmospheres would have entirely counterbalanced the force of chemical affinity, since, to produce any chemical change, it would then have had to overcome a greater force than it possessed.

Conversely, when Calcite was inclosed with a rather strong solution of chloride of sodium and sulphate of copper (which would decompose into malachite, sulphate of lime, and carbonic acid) the *decrease* of volume is estimated at about 8 °/₀ of the Calcite altered; so that, under pressure, mechanical force is the very reverse of being opposed to the chemical change. Three experiments, under a pressure of 90 atmospheres, showed that the amount of chemical change was 17 °/₀ *more* with the pressure than without—thus proving that pressure had, as it were, increased the force of chemical affinity. Calculating on the principles already explained we would conclude that a pressure of 530 atmospheres would have caused the action to take place at double the rate—and therefore the chemical action is equivalent to the expenditure of that amount of mechanical force; so that the contraction of 8 °/₀ in the Calcite must entail a loss of mechanical force capable of raising 28 times the weight of the Calcite altered to the height of 1 metre, in the time required for the chemical change—which amount of mechanical energy becomes latent, as it were, to be again given out if the chemical affinities became inverted.

Other experiments similarly show that pressure causes, in some cases, a slower, and in others a quicker, chemical action; and Mr. Sorby thinks the facts indicate that *pressure weakens or strengthens chemical affinity according*

*as it acts against or in favour of the change of volume*—as if chemical action were directly convertible into mechanical force, or mechanical force into chemical action, in definite equivalents, according to well-defined general laws, without any intermediate action of heat or electricity.

The importance of these facts, as likely to aid the elucidation of many of the hitherto obscure problems connected with chemical and physical geology, will be evident to every one acquainted with the subject. In this memoir, Mr. Sorby does not attempt to enter on this part of the subject; but he points out that a number of facts connected with metamorphism, slaty cleavage, and the phenomena of mineral veins—which have hitherto appeared inexplicable—are readily explained if mechanical force be directly correlated to chemical action.

## REPORTS OF GOVERNMENT INSPECTORS OF COAL MINES.

The Reports for 1862 of the Government Inspectors of Coal Mines have just been issued. From these we find that the number of deaths amounted to 1,133, against 943 in 1861. Of these 1,133 deaths, 204 resulted from the Hartley accident, 59 from the Edmond's Main explosion, and 50 from the accident at Gethin. The number of separate explosions of fire-damp was six less, but the deaths resulting from them have increased by 71.

The total number of accidents in coal mines during the year, in England, Scotland, and Wales, was 738, against 811 in 1861. The number of accidents occurring in iron-stone mines in 1862 was 85, resulting in 105 deaths. The accidents from falls show a decrease both in number and fatality, and the same applies to accidents in shafts.

In Mr. Dunn's district (North Durham, Northumberland, and Cumberland), the explosions have been, for the Northern district, especially fatal, five separate accidents having resulted in 21 deaths. With one exception of a fall of roof, where two lives were lost, the falls of coal and roof have in each instance resulted in one death only, and two deaths have resulted from each shaft accident.

In Mr. Atkinson's district (South Durham), with the exception of falls of coal, where two accidents caused four deaths, no accident which occurred during the year has resulted in more than a single death, and none of them deserve special notice.

In Mr. Dickinson's district (North and East Lancashire), things have been equally satisfactory, only 59 deaths having been caused by 56 accidents. The cases in which more than one death followed were—one explosion, one fall of coal, and one breakage of a chain.

In Mr. Higson's district (West Lancashire and North Wales), affairs have not been quite so favourable, 82 deaths having followed from 74 separate accidents. The casualties resulting in more than one death were—one fall of roof, where two lives were lost; one accident whilst in cage, where two lives were lost; and three accidents from things falling in the shaft, which resulted in nine deaths.

In Mr. Morton's district (Yorkshire), there were only four accidents during the year, resulting in more than a single death, those four being the Westwood explosion, on April 4, where six were killed; the Hostingley explosion, on August 7, where a man and a boy were killed; the Edmund's Main accident, on Dec. 8, referred to above; and the Wharncliffe Silkstone fall of coal, which killed a man and a boy. Mr. Morton mentions that (omitting the Edmund's Main), the loss of life in his district has never been so small during the last twelve years. He repeats that nearly all the fatal and non-fatal explosions of gas which occurred last year in the Yorkshire pits were clearly attributable to the improper use of candles for lighting the mines, and of gunpowder for blasting the mineral. In the ironstone mines seven persons were killed by seven separate accidents.

Mr. Morton refers to a case of burning, which occurred at Messrs. Carter & Co.'s Allerton Bywater Colliery, near Normanton, where a miner, with a good and locked safety-lamp, was hewing in a place where it was suspected that inflammable gas might appear; the point of his pick sharply struck bright sparks from a "brass lump" in the coal, and he was immediately scorched by a blaze of fire-damp.

In Mr. Hedley's district (Derbyshire), the accidents have in each instance, with one exception, where a fall of roof killed two, been attended by one death only.

Mr. Baker reports that in his (South Staffordshire) district 111 separate accidents resulted in 114 deaths, thus showing little more than one death to each accident.

In Mr. Evans's district (South Wales), five explosions resulted in fifty-four deaths.

We shall refer more fully to these reports in a future number.

## Notes and Memoranda.

New Boring Machine.—A new form of boring machine has been completed by M. Leschot, differing essentially from those of M. Sommeiller and other inventors (which act by percussion, imitating the action of the borer worked by hand), inasmuch as M. Leschot's apparatus, on the contrary, imitates the action of the carpenter's augur. It avoids, however, the great difficulty which has hitherto been found in this arrangement—that is, the boring out with the augur of the whole of the rock required to be removed to make the hole; for the perforator adopted here is *annular*, and only cuts out a cylindrical groove round a solid nucleus, which is left standing in the centre of the hole, but is afterwards easily removed—thus greatly diminishing the time and labour required. The principal tool is a cylindrical iron tube, with an exterior diameter corresponding to the size of the hole to be bored, and an interior diameter corresponding to that of the nucleus. At the bottom of this tube is fixed the perforating tool—formed of a tube the same diameter as the other but shorter, and carrying a ring set with a series of black diamonds. This tube being given a rapid rotary motion, the diamonds quickly cut away the rock; and the groove is cleaned out by a current of water, forced, at a certain pressure, through the interior of the tube.—In one experiment made with this tool, a man was able to sink a hole 1·8″ in diameter with a nucleus of 1·2″, from ¾″ to ½″ per minute in a block of granite; and in another case, where a man with a borer was only able to sink a hole 2″ in diameter at the rate of 24″ per hour, with this machine he was able to sink at the rate of 60″ per hour.—The ring of diamonds, the original cost of which is about 5*l.*, was not sensibly worn after boring 80′ of the hardest rock; and even when the diamonds are worn down to the setting, the remains are said to be saleable for nearly 4*l.* No mechanical details have been yet given; but as the apparatus is at work on trial at the St. Chamond mines we shall probably soon hear fuller particulars about it.

The Use of a Blast in Reverberatory Furnaces.—The practice of forcing air into reverberatory furnaces, now so long generally abandoned, has been again adopted at Seraing, for heating furnaces in manufacturing iron. The result is said to be a saving of upwards of 20°/o in the value of the fuel consumed, principally from being able to substitute slack for large coal. In other respects, the use of the blast seems to be attended with

certain advantages and certain disadvantages, the balance for which is not easy to ascertain.

CRYOLITE CRYSTALS.—Prof. Nöggerath has obtained a fine series of cryolite specimens from Greenland, some of a high degree of purity, very transparent and compact—much increasing the icy appearance of the mineral. Other samples contained siderite embedded in the crystals, and sprinklings of galena and copper pyrites.

BESSEMER STEEL RAILS.—In their last Report, the Directors of the London and North Western Railway Company, state that they have been making trials at various points of a new description of rail, made of steel by Bessemer's process. The results are important and satisfactory. Some of these rails were laid down at Rugby, Stafford, and Crewe in March, 1862, and are wearing well. In May, 1862, some were laid down at Camden parallel with the best description of iron rail. So severe was the test that the iron rails speedily gave way, and had to be frequently removed worn out, while the steel rails continue to show little appearance of wear. Having regard to the importance of procuring the most efficient rail, so as to avoid the frequent renewal now found necessary on the main line and in the principal stations, the Directors have deemed it expedient to adopt and substitute the steel rail to that extent at least; and, having agreed with Mr. Bessemer as to the royalty to be paid for the use of his patent, they have made the needful arrangements at Crewe for the production of steel to the extent of 10,000 tons per annum.

PRACTICAL APPLICATION OF MELTED "ROWLEY RAG."—At a recent meeting of the Manchester Geological Society, a paper was read by Mr. J. Plant, "On the effect produced on Rowley Rag by heat; and on the practical application of its products to useful purposes." Referring to the classical experiments of Mr. Gregory Watt, in 1804, on this trap rock—which appears to be a Melaphyre, that is, an indistinctly mixed rock, intermediate between ordinary greenstone and black basalt—the author proceeded to detail the various attempts made, since 1846, to turn it to practical and economical uses. The first patent obtained was in that year by Mr. Borgognon, a foreigner; — which was followed by a second in 1851, by Mr. Henry Adcock; by a third, in 1852, by Mr. W. G. Elliott; by a fourth, in 1854, by Mr. J. T. Chance; and by a fifth, in 1855, by Messrs. Chance and Adcock. There seems to have been little difference in principle between these various patents, which all proposed fusing the trap – with a flux if necessary – and casting it in moulds, with colouring matter if required; except that, in the more recent patents, it has been proposed to roll and press the fused mineral into slabs, sheets, or bars, with plain or raised ornamental surfaces, and to polish the surface—to treat it in fact like plate-glass, and some of the ductile metals. Some of the specimens of the fused trap—cooled under various circumstances, and cast in various forms—were exhibited; but it was stated that, in a business point of view, the matter had not succeeded, the cost of production being apparently too great.

ORIGIN OF TRAP AND OTHER CRYSTALLINE ROCKS.—After the reading of Mr. Plant's paper, on Rowley Rag, before the Manchester Geological Society, an interesting discussion occurred on the origin of trap and other crystalline rocks, in which the President (Mr. Dickinson), Signor Berruti (of the Geological Survey of Italy), Mr. Hull, and Mr. Atkinson took part—Signor Berruti stated that, in the neighbourhood of a volcano, rocks of considerable thickness might be seen—the top part of which was obsidian or volcanic glass, the middle portion of a duller texture and more earthy or stony character, while lower still (where the mass must have been a long time cooling) it was very similar to the basalt or Rowley Rag. Mr. Hull said that nothing was more settled in Geology than that the different varieties of trap resulted from differences in the rate of cooling; but that when we come to granite there is a distinction. It was, however, now known

by clear observation that granite was nothing else but a melted stratified rock, passing sometimes by imperceptible gradations into slate rocks. Granite is a metamorphic rock, and in the case of Dartmoor, the bosses of granite appear to lie in the very strike of the beds, and to occupy the place of certain members of the slate rocks of the district.—Mr. Dickinson said he was disposed to think that geologists had settled far too much, and had generalised too rapidly. The way in which many of the trap rocks are found blended with the slates, &c., appeared to him a difficulty to be got over before they could be recognised as due to igneous action—for instance the floating whins of Scotland found interspersed with the Coal measures. It is assumed that these emanate from chimneys, but he had never seen one, nor met a person who had seen one.—Mr. Atkinson pointed out that near Darley Dale they had, he considered, come on one of those pipes of outburst, having sunk 200 yards without getting through the toadstone.

Association for the Prevention of Steam Boiler Explosions.—From Mr. Fletcher's report at the last monthly meeting of this Association, on July 28th, it appears that during June 324 engines and 450 boilers were examined. Out of these two were found dangerously fractured; two safety-valves dangerously out of order; one furnace with a serious over pressure; and one dangerously deficient in water. One explosion of a very fatal character occurred to an ordinary two-flued mill boiler, by which ten persons were killed and four seriously injured. It was not under the inspection of the Association. The cause of the explosion had been attributed differently, to over-pressure and shortness of water; but investigation showed that such was not the case, and that the explosion was simply due to the defective quality of the plates of which the boiler, on examination, was found to have been made. Among other things, Mr. Fletcher called attention to the shortsighted economy of purchasing low-priced boilers; and to the importance of having all boilers thoroughly tested with hydraulic pressure.

Institution of Mechanical Engineers.—The annual provincial meeting of the members of this Institution commenced at Liverpool on July 4th. Mr. William Clay presided, in the absence of Mr. Robert Napier, the President. Among the papers read was one by Mr. Coulthard, a "Description of the New Iron Works at Grosmont," in the Cleveland iron district, which entered into very technical and minute details, and upon which a considerable amount of discussion took place.

Obtaining Oil and other Products from Shale.—Mr. J. McLean proposes an "improved apparatus for obtaining oil and other products from shale and the like bituminous minerals," which he describes as consisting of a number of cast-iron retorts, arranged horizontally, in sets of three to each furnace. Each retort is about 7′ 6″ long by 3′ wide and 1′ 6″ deep; all of an oval form in section, and about 2′ 6″ thick. Two of the retorts are arranged within 1′ 4″ of each other, and the third is placed in the centre space above them. The furnace grates are about 3′ 6″ long by 2′ wide, and 3″ fire-brick flags are placed between them and the retorts to support the latter. The retorts are fitted with doors of boiler-plate, and each retort is provided with two outlet pipes, by which the distilled products pass off. These pipes are passed through condensing cisterns and then descend vertically to the main, by which the products of the retorts are conveyed to the collecting tank. A second condensing apparatus is provided for any overflow of gas or vapour not condensed in the first cistern, as well as an outlet in the main for separating the ammoniacal liquid from the oil.

The Bessemer Process applied to Italian Iron.—Messrs. Ponsard, Perazzi, Grabau and Devincenzi have been employed at Sheffield in making investigations on the applicability of the Bessemer process to Italian iron, from which it seems that the samples of steel produced from the mangani-

ferous iron of Follonica were of very equal quality, as also those furnished by the Lombardic grey-iron—indeed one could scarcely be distinguished from the other. The steel obtained from an equal mixture of Lombardic and Tuscan iron was of a somewhat inferior quality, and the Mongiana iron furnished only indifferent steel. It appears from this that the Tuscan and Lombardic iron, particularly the manganiferous iron, produces a superior steel; a fact of considerable importance to the Italian iron-masters, fuel being very costly in that country.

Obtaining Iron from the Residues of Pyrites and Poor Copper Ores.—Mr. W. Henderson, of Glasgow, has specified (3,438) improvements in obtaining iron and steel from certain ores and residual products. These relate to methods of producing cast-iron from the residues of iron and copper pyrites after all the copper and sulphur have been extracted. These residues consist principally of oxides of iron which still contain from 3 to 9 °/₀ of sulphur, and which cannot therefore be used with advantage for the manufacture of iron by any system at present adopted, particularly when the residues are from copper pyrites, or iron pyrites containing copper, and which, consequently, contain copper besides a certain proportion of sulphur—rendering them still more unfit for the manufacture of iron. By treating burnt copper pyrites by the process patented by Mr. Henderson in 1859 (2,900) practically all the copper and sulphur are extracted, and a very pure oxide of iron remains as a residue; and when found desirable iron pyrites' residues containing no copper may be treated in the same manner, and a very pure oxide of iron obtained. These residues, being in a very fine state of division, cannot be used advantageously in a blast-furnace for they produce little or no slag and pass rapidly through the furnace without being properly reduced—choking the furnace or being blown away by the blast. In order to produce cast-iron from these residual oxides, Mr. Henderson proposes mixing them with from 25 to 30°/₀ of bituminous coal (as free as possible from sulphur and ash), 3°/₀ of common salt, 3°/₀ of lime, or 6°/₀ of carbonate of lime; all these are in fine powder, and being intimately mixed with the oxides of iron the whole is fixed in a reverberatory furnace. If anthracite coal, or coke, is used, a better iron will be produced, and 22 to 25°/₀ will be sufficient; but an excess of carbonaceous matter is always advantageous. Charcoal in coarse powder may also be substituted for the coal or coke, and will produce a better quality of iron; and for producing steel the same mixtures are used. When intimately mixed, the whole is charged into a reverberatory furnace, consisting of a balling and puddling hearth, and a long sloping bed or table with a hopper fixed at the top or colder end. The mixture is charged into this hopper, and melted as rapidly as possible, while kept gradually moved towards the flame-bed of the balling hearth; the floor of the furnace being placed on such a slope as will ensure the mixture descending of its own accord, and being made large enough to contain as much ore as will supply the furnace-bed with a constant quantity as fast as it can be worked up. The ore, as it descends against the flame, is steadily reduced to a spongy mass, when it is withdrawn from the furnace, and rolled in the usual manner. Where black-bands can be obtained, sufficiently free from earthy impurities, they may be substituted for the coal or coke, or charcoal, due regard being paid to the proper proportions. To reduce a black-band containing 25°/₀ of carbonaceous matter, 40°/₀ of iron, from the state of protoxide to a metallic state, only 10 or 12°/₀ of carbonaceous matter will be consumed, while from 13 to 15°/₀ will remain free. A mixture, therefore, of ore of the foregoing composition reduced to fine powder in the proportion of two of black-band to one of the residues will produce cast-iron.

Reverberatory Heating Furnaces.—Mr. John Clayton in his patent for improvements in reverberatory furnaces for heating large masses of iron and steel, and in economising the waste heat of such furnaces (specif. 3,384),

proposes making the bottom of the middle of the furnace moveable, supported on a wheeled carriage, so that it can be drawn from under the reverberating arch of the furnace, and the iron or steel to be heated placed thereon. The moveable bottom may then be restored to its place with the mass of iron or steel to be heated. When heated, the mass may be removed on the moveable bottom to the rolls or other machinery by which it is to be operated upon. The cinder or slag produced during the heating of the iron or steel falls on the bottom of the furnace, which is made concave, and inclined downwards from the middle towards either side, so that it is thus conducted to the sides of the bed of the furnace, from whence it falls into two cinder wagons, which work under the carriage, carrying the moveable furnace bottom—working on inclined tramways. The sides and bottom of the furnace are closed by doors; those closing the upper part of the sides of the reverberating arch opening by a vertical sliding motion; while those closing the space underneath the bed of the furnace work upon hinges, and are provided with ventilators, by which air can be admitted to the pile to regulate its temperature. The sliding doors have small sight doors working on hinges. The carriage is moved by means of a chain, which may be worked by a steam engine or other means. Double-grated furnaces are employed, the bottoms of which are concave. Each grate has a door working on hinges, with a small ventilator in its middle, to regulate the quantity of air entering the fire. The improvements in economising the waste heat of the furnaces consist in applying it to heat two horizontal steam-boilers situated over the furnace, which are supported on columns, and are provided with tubular flues, through which the heated air from the furnace passes to two vertical stacks.

Casting Bessemer Steel.—Messrs. Petin, Gaudet, and Co., of Rive de Gier, have patented a peculiar arrangement of moulds to be employed in casting ingots of steel. It consists in making such moulds syphon-shaped, and pouring the metal first into a main compartment, which communicates at its lower end only with one or more other compartments by lateral apertures, through which the metal flows, rising slowly and steadily, in such other compartments, although poured rapidly into the main or filling compartment. Each of the compartments in connection with the main compartment is closed at the top, with the exception of a small aperture for the escape of the air and gases. Any number of the compartments may be combined; and the several parts are bolted together, so as to admit of unbolting to get out the ingots.

Improvement in Bessemer Converting Vessels.—Mr. E. B. Wilson proposes to dispense entirely with the axes, pinions, centres, or trunnions hitherto employed in suspending converting vessels used in the Bessemer process, and to cause such vessels to rotate upon hoops or rockers. One mode of carrying out this consists in fitting a segment or hoop of wrought or cast-iron or steel on to each side of the converting vessel, and to support the same in any suitable framing, forming a base or stand to the vessel; and another of making the hoops or segments rest upon anti-friction pulleys or rollers contained in the base or support. The turning or rotation of the vessel, for the purpose of pouring out its contents, may be accomplished by a lever, or by the aid of gearing.

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# Mining, Quarrying, and Metallurgical Review.

## WESTERN COUNTIES.

Mining in Cornwall continues very dull, and there is scarcely anything new of importance to report. Indeed, instead of improvements, the mines on the whole show a falling off. The copper standard continues to have an upward tendency, but as the produce of this metal in the county is steadily diminishing, this has not such a cheering effect as it would otherwise have. The tin standard, on the other hand, upon which the prosperity of West Cornwall principally depends, has again unexpectedly declined.

The fall of the tin-standard, resulting from the fall in the price of the metal, has been very generally attributed to underselling on the part of some of the new tin-smelting companies, who in consequence are not in quite such high favour with the miners as they were a few months back, when great hopes were expressed of the advantages to be gained by greater competition among the buyers of ores. When the tin trade was entirely in the hands of the three old firms—the Messrs. Bolithos, Daubuzes, and Williamses—the price could always be controlled, and kept at the highest point compatible with the supply and demand; but it is now said that the necessities of the smaller capitalists, who have recently come into the trade, are taken advantage of by buyers, and that, consequently, prices have been reduced below a point at which they might otherwise have been fairly maintained.

The quarterly sittings of the Stannaries Court commenced at Truro on the 12th. There has been no case of particular interest, but, of course, a number of pursers' petitions; among others, Painter *v.* Voyle and others—East Alfred Consols—Westcomb *v.* Brutton and others—Prosper United Mines—Sleeman *v.* Burton—South Wheal Lovel. Among winding-up petitions were Old Tolgus United; Cathedral Mining Company; Carn Vivian Mine; Huntingdon Mining Company; Herodsfoot Consols East Mining Company; Fowey and Par United; and Penhaldarva Mine.

At *Nanjiles* they are reported to have cut a good course of ore in sinking the engine-shaft below the 90. At *Clifford Amalgamated* it is said that they have an improvement in the bottom levels. At *Dolcoath* the western and eastern parts are opening up better than was expected. At *South Tolgus* the piston-rod of the pumping ngine broke on August 14th, and it will take some time to drain the mine from the consequent inundation.

At *Copper Hill* meeting (on July 27th), the shares were subdivided into 1,024. At *Trencrom* meeting (on July 29th), it was resolved that the London office of reference be abolished. At *North Robert* meeting (on Aug. 3rd), it was agreed by the holders of a small number of shares that the services of Capt. J. Richards, of Devon Consols, as managing agent, were not further required. A special meeting of the adventurers was, however, called (on Aug. 21st), for the purpose of rescinding this resolution, which was accordingly done, the meeting expressing full confidence in Capt. Richards' management of the mine. At *Great North Tolgus* meeting (on Aug. 4th), it was resolved that the property be offered by public auction, and that the reserve price be 1,000*l.* At *East Seton* meeting (on Aug. 12th), it was resolved that the manager be instructed to purchase a suitable engine to develop the mine. At *St. Ives Wheal Allen* adjourned meeting (on Aug. 12th), Mr. Robinson was appointed purser, and Capt. John Nancarrow, of St. Ives Consols, manager, in the place of Capt. Thomas Richards, resigned. At *Wheal Grenville* meeting (on Aug. 20th), it was resolved that Polgine be worked as a separate mine, under the name of South Wheal Grenville, in 6,000 shares, which be offered *pro rata* to the Grenville holders.

Among new concerns announced during the month are:—the *Great Chandos Copper and Tin Mining Company*, with a capital of 30,000*l*., in shares of 3*l*. each, formed for the purpose of working a piece of ground situated near Wheal Jewell, West Damsel, Trefusis, Ting Tang, and Grambler and St. Aubyn. The purchase-money to be 5,500*l*., of which 3,000*l*. is to be taken in paid-up shares. The *West Wheal Martha Mining Company*, with a capital of 30,000*l*., in shares of 2*l*. each, propose working the Great Sheba Mines. The purchase-money is fixed at 8,800*l*., one-half of which is to be taken in paid-up shares. It is proposed to work *Wheal Esther* mine (in the parish of Llanivet) on the cost-book system. It is to be divided into 2,048 shares. The *West Wheal Friendship Copper Mining Company*, limited, with a capital of 30,000*l*., in shares of 1*l*. each, has issued a prospectus. The ground proposed to be worked is near Wheal Friendship, and 6,000*l* is to be paid for the sett, of which 5,000*l*. is to be taken in shares.

## WALES AND THE BORDERS.

SOUTH WALES.—The iron trade in this district has decidedly improved; there has been a good demand both for rails and bars, and all the large iron works seem to have been regularly and steadily employed all through the month. The export trade has been brisk, a considerable quantity of railway and other iron having been sent to America, as well as to Italy, Spain, and France. The Cwmbran forge is about to be put in working order, and the new proprietors, Messrs. Weston and Grice are, it is said, about to make extensive additions and alterations. Prices have been firmly maintained, and it is not unlikely that a further advance may take place in bars.

Emigration from all parts of South Wales is still going on, and it is said that about 500 a month leave from the iron works alone. If this movement is not stopped the iron masters will soon be seriously short of hands.

The improvement in the tin works of South Wales continues, and has increased, more especially where coke plates are made, and there is a prospect that the tin trade will before long resume its former prosperous state. As evidence of the increased activity in the trade, and the promising future prospects, it may be mentioned that extensive new works are being built at Melyncrythan, near Neath, and part of the old Llanelly iron works is also being transformed into a tin-plate establishment. The Pontnewydd works are to be started without delay, and more hands are being engaged at several of the works now going on, and these circumstances clearly show that the trade is decidedly improving.

The coal trade has been in a much more satisfactory state, although prices still continue low. Freights have gone down considerably in consequence of the large arrivals of vessels. The Risca collieries have recommenced working, and it is said that a contract has been secured which will keep them going for some time.

From the returns from Cardiff it appears that during the month of July there were shipped from that port 136,259 tons of coal, 23,237 tons of iron, and 1,153 tons of coke—showing a considerable increase on the quantities exported during June. The returns of the exports from Newport, Llanelly, Swansea, and Neath are also very satisfactory, and show a large increase over those of June.

The arrivals into Swansea during the month include: copper ore from Aveiro, Bolivia, Cuba, Coquimbo, St. Helena and Rouen; iron ore from Cherbourg; silver ore from Coquimbo and Cherbourg; zinc ore from St. Malo; plumbago from Borgo; and copper regulus from Cuba, Bolivia and Taltal.

GLOUCESTERSHIRE.—Among the imports into Bristol during the month have been: 720 tons of sulphur ore from Pomaron; 882 tons of sulphur from Arklow; 52 casks of metal from Rotterdam; 1,496 bars of iron from Gothenburg; 87 barrels of sulphur from Liverpool; 20 tons of silver ore from Aberystwith; 150 tons of lead from Sines; 460 tons of pig-iron and 150 tons castings from Glasgow and Belfast; 70 tons of burnt ore from Runcorn; 40 tons of tin plates from Newport; 60 tons of iron from Cardiff, and 46 tons from Sydney. The exports include: 2,674 tons of iron, and 295 tons of coal. During the month of July, 766 tons of coal, and 1,284 tons of iron were exported over sea from Bristol, against 588 tons of coal, and 2,573 tons of iron during the corresponding month last year—showing an *increase* of 178 tons in coal, but a decrease of 1,289 tons of iron. From the returns of the trade of the port we find that the tonnage of the shipping from foreign ports which entered Bristol during 1862 was 277,229 tons, against 262,327 tons during the previous year—showing an increase of 14,902 tons.

The imports into Gloucester have comprised: 50 tons of iron from Swansea; 90 tons of coal from Haverfordwest; 50 tons from Saundersfoot; and 280 tons of sulphur from Pomaron.

NORTH WALES.—A prospectus has been issued of the *Gronant Silver-Lead Mining Company*, limited, with a capital of £11,340, in 2,520 shares of £4 10*s*. each. The object of the proposed company is to purchase and work a silver-lead mine in the parish of Llanasa, in Flintshire.

The Croisier Valley and Port Madoc Freehold Slate Company are reported to have purchased a freehold property near Port Madoc, for £15,600, part of which will be paid for in shares, and £8,000 will remain unpaid until the shareholders have received a dividend of 15 per cent.

The *Galt-y-Llan Slate Quarry* is about to be worked by a limited company, with a capital of 50,000*l*., in shares of 10*l*. each. The property is said to be favourably situated, and the slate of good quality.

## MIDLAND COUNTIES.

STAFFORDSHIRE AND WARWICKSHIRE.—The iron trade of this district still remains very dull, caused in a great measure by the continuance of the puddlers' strike. It is hoped, however, that this is now at an end, as, at a meeting of the South Staffordshire ironmasters, held at Wolverhampton on August 19th, it was resolved to advance the puddlers' wages 1*s*. per ton. This advance necessitated the price of finished iron being raised 10*s*. per ton, although it does not seem probable that this price can be maintained, as there are not nearly sufficient orders to keep the works in full operation.

The coal trade has shared in the general inactivity, but ironstone has been in tolerably good request.

The *Gresley Wood and Swadlincote Colliery Company*, limited, has issued a prospectus. The company is formed for the purpose of working the collieries of the same name near Burton-on-Trent. The capital is to be 100,000*l*., in shares of 50*l*. each.

## NORTHERN COUNTIES.

NORTHUMBERLAND AND DURHAM.—The iron trade keeps pretty active, a good business has been done, and the number of mills and furnaces in Cleveland is reported to be steadily increasing. The coal trade is also improved, and the pits have been working longer time. The gas and coaking coal collieries have been doing much better, many of them having been fully employed.

A bed of rock salt has been discovered near Middlesboro', about 200 fms.

from surface. It seems to be a valuable deposit, but would require a considerable outlay of capital to make it available.

The exports from the Tyne during the month include :—161,912 tons of coal; 8,409 tons of coke; and 52,960 cwts. of iron. The imports were cargoes of pyrites from Levanger, Antwerp, Rotterdam, Gefle, Salajo, Dordt, and Seville; cargoes of copper ore from Levanger, Stavanger, Seville and Carthagena; bar iron from Gothenberg and Stockholm; 1,020 bars of lead from Almeira, 13,366 from Carthagena, 1,029 from Alicante, 1,562 from Escombrera, 2,309 from Pomaron and 3,881 from Garrucha; cargoes of manganese ore from Pomaron, Villa-Real, Huelva and Salajo; cargoes of sulphur ore from Pomaron, Cadiz, Sefle and Drontheim.

## SCOTLAND.

The coal trade has been inactive, with but little demand either for home use or for export.

The pig-iron market has slightly improved, and shipments for the month show a considerable increase. The following are the shipments for the first seven months of the present year, as compared with the corresponding seven months of 1862, 1861, and 1860:—

| Month. | 1863. | 1862. | 1861. | 1860. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| January.. .. .. .. | 30,467 | 44,729 | 39,267 | 38,625 |
| February .. .. .. | 38,867 | 39,614 | 33,070 | 26,883 |
| March .. .. .. .. | 50,909 | 44,495 | 33,474 | 39,152 |
| April .. .. .. .. | 57,345 | 63,160 | 62,622 | 50,585 |
| May .. .. .. .. | 67,820 | 70,461 | 82,036 | 66,701 |
| June .. .. .. .. | 53,806 | 42,167 | 57,201 | 40,712 |
| Week ending July 4 .. .. | 13,228 | 8,298 | 12,970 | 11,603 |
| " " 11 .. .. | 13,161 | 8,236 | 12,077 | 7,133 |
| " " 18 .. .. | 14,613 | 15,032 | 11,279 | 14,400 |
| " " 25 .. .. | 10,179 | 10,015 | 11,978 | 14,710 |
| Total .. .. | 350,395 | 336,207 | 353,974 | 310,504 |

It will be seen that, on the whole, the results for the present year may be regarded as satisfactory, for, although falling short of those obtained in 1861, they show a considerable increase over 1862.

## FOREIGN AND COLONIAL.

France.—The iron trade in the Haute Marne district continues much the same, and a fair amount of orders are still received. Pig-iron has remained steady at from 5*l.* to 5*l.* 2*s.* First-class sheets have been quoted at from 10*l.* to 10*l.* 8*s.* per ton. The Herserange and Moulaine Works which were not purchased at the up-set price of 40,000*l.*, will probably be offered for sale with the Grandville forge; the price being considerably reduced. The blast-furnaces about to be established near Longuy in Moselle, are expected to turn out 11,000 tons of pig annually.

Belgium.—The Belgian iron market continues fairly active, without alteration in prices. The rolling works of the Chatelineau Company have been greatly extended and improved, and have been already put into partial activity. It is said that a company is to be formed for the purpose of working blast-furnaces on Mons. Fabry's system, in which coke is replaced by raw coal.

From the official statement of the Minister of Finance, it seems that on the whole Belgian metallurgical industry may be considered to be in a favourable condition. Total quantity of rails exported during the first six months of the present year amounted to 22,827 tons, showing an increase of 5,970 tons over the corresponding period of 1862. The export of bars also shows a decided increase.

The Belgian coal market has been rather inactive, nor does there seem much chance of its improving for some little time to come. It appears from official statements, that the exportation of coal during the first six months of the present year, has increased 164,124 tons over the corresponding period of 862.

GERMANY.—A company called the *Neustadt Charcoal Ironworks Company*, with a capital of 230,000*l.*, in shares of 20*l.* each, is to be formed for the purpose of carrying on the iron works of that name. The purchase money is 160,000*l.*

BRAZILS.—From *St. John Del Rey* it is reported that the produce for June was 44,961 oitavas; cost for ditto, 10,039*l.*; profit for ditto, 7,292*l.* Produce 13 days of July, 14,335 oitavas; yield, 5,804 oitavas per ton. Limited supply of stone.

# Record of the Mining and Metal Markets.

## METALLIC-ORE MARKETS.

TIN.—The standards for black tin were again reduced, on August 10th, 3*l.* on fine and 2*l.* on common, and now stand at:—

| | | | |
|---|---|---|---|
| Superior Fine | .. £112 .... | Superior Common | .. £108 |
| Second Fine | .. 109 .... | Second Common | .. 107 |

COPPER.—At the four Cornish sales we give this month, the number of tons, average produce, quantity of fine copper, average price per ton, and standard have been as follows:—

| *Date.* | *Tons.* | *Produce.* | *Fine Copper.* Tons. cwt. | *Price per ton.* | *Standard.* |
|---|---|---|---|---|---|
| July 30. | .. 3,346 | .. $7\frac{1}{4}$ .. | 241 19 .... | £5 12 6 .... | £115 15 0 |
| Aug. 6. | .. 3,533 | .. $6\frac{5}{8}$ .. | 235 15 .... | 5 4 0 .... | 119 4 0 |
| „ 13. | .. 2,885 | .. $6\frac{7}{8}$ .. | 197 18 .... | 5 8 0 .... | 118 11 0 |
| „ 20. | .. 5,173 | .. $5\frac{3}{4}$ .. | 298 2 .... | 4 8 0 .... | 124 8 0 |

At the sale of the 30th the standard advanced 15*s.*; at that of August 6th 15*s.*, and again at that of the 10th 10*s.*, making in all an advance of 2*l.* At the sale of the 20th the standard declined 1*l.*

LEAD.—Comparing this month's sales with those of last, we find that prices have slightly advanced.

## COAL MARKETS.

LONDON, *August* 28*th.*—From the returns of the Registrar of the London Coal Exchange, of the quantity of sea-borne coal, culm, and cinders, imported into London in the month of July, we learn that the total quantity was 259,817 tons, against 269,408 tons during the corresponding month of last year, showing a *decrease* of 9,591 tons.

The following are the particulars of the 259,817 tons imported during July:—

| | | | | | |
|---|---|---|---|---|---|
| Newcastle .. | 87,644 tons, in | 227 ships | Scotland .. | 2,460 tons, in | 13 ships |
| Seaham .. | 22,619 „ | 91 „ | Wales .. | 13,446 „ | 29 „ |
| Sunderland . | 66,132 „ | 157 „ | Yorkshire .. | 3,806 „ | 38 „ |
| Middlesbro'. | 6,536 „ | 26 „ | Small .. | 2,493 „ | 13 „ |
| Hartlepool.. | 52,715 „ | 192 „ | Cinders .. | 1,360 „ | 7 „ |
| Blyth .. | 286 „ | 1 „ | | | |

The quantity of coal imported by railways and canals during the month of July was 127,109 tons, against 109,989 tons during the corresponding month last year—showing an *increase* of 17,120 tons.

In the London coal market a fair steady business has been done during the month. On the 3rd, the ships arrived were 60—market active. The prices were: Hetton Wallsend, 18*s.* 6*d.*; Braddyl's Wallsend, 17*s.* 3*d.*; Eden Main, 16*s.* 6*d.*; Kepier Grange Wallsend, 16*s.* 6*d.*; Hasting's Hartley, 16*s.* 9*d.*; Butes Tanfield, 13*s.* 6*d.*; Lambton Wallsend, 17*s.* 3*d.* On the 5th new ships 11, market inactive. On the 7th, new ships 29, market firm, in some instances an advance of 3*d.* On the 10th, new ships 120, a reduction of 6*d.* On the 12th, new ships 87, market dull. On the 14th, new ships 50, all descriptions in fair demand. On the 17th, new ships 32, market steady. On the 19th, new ships 46, market firm. On the 21st, new ships 130, market active: Hartley's were reduced 6*d.* On the 24th, new ships 58, market heavy: market 1*s.* lower for steam coal. On the 26th, 12 new ships, and trade heavy. 28th, new ships 20, of which 14 were steamers; market firmer. The prices were: Haswell Wallsend, 17*s.* 3*d.*; Stewart's Wallsend, 17*s*; Russell's Hetton Wallsend, 16*s.* 6*d.*; Braddyll's Wallsend, 16*s.* 3*d.*; South Hartlepool Wallsend, 16*s.*; South Kelloe Wallsend, 15*s.* 9*d.*; Heugh Hall Wallsend, 15*s.* 9*d.*; Eden Main, 15*s.* 6*d.*; Davison's West Hartley, 15*s.* 9*d.*; Lambert's West Hartley, 15*s.* 6*d.*; West Hartley, 15*s.* 9*d.*; Tanfield Moor, 12*s.* 6*d.*; Bute's Tanfield, 12*s.* 6*d.*

LIVERPOOL.—From Messrs. J. and T. Platt's Coal Circular for August we find that the quantity of coal, cannel, coke, and patent fuel shipped from Liverpool to foreign and colonial ports during the month of July was 51,024 tons, against 52,287 tons during the corresponding month of last year—showing a *decrease* of 1,263 tons. The total shipments from January to July were 299,318 tons, against 340,951 tons in the corresponding period last year—showing a *decrease* of 41,633 tons. The exports coastwise during July were 9,625 tons, against 7,014 tons during the same month last year—showing an *increase* of 2,611 tons. The total exports coastwise from January to July were 50,849 tons, against 39,174 tons during the corresponding period of last year—showing an *increase* of 11,675 tons.

CONTRACTS.—The Royal Spanish Naval Commission invite tenders for the supply of 25,000 tons of coal to the naval station of the Philippine Islands.

## SHARE MARKETS.

LONDON, *August* 28*th.*—Our market has been extremely dull and inactive throughout the month, which is however attributable to a great extent to the absence of the leading dealers from town. During the first half of the month, the amount of business done was insignificant, but there is rather more doing towards the close. Besides the usual fluctuations in East Caradon, the only noticeable feature has been the advance in Clifford Amalgamated of nearly 10*l.* per share.

*East Caradon* still continues to absorb the largest amount of attention, and an extensive business has been done in the shares, which on the whole have declined 2*l.* on our closing prices of last month, after various fluctuations ranging from 27*l.* to 31¾*l.* Shares opened weak at 30½*l.*-31*l.*, but were a shade better for the few following days, although they again drooped

towards the 7th, on which day they closed 28½l.-29l., about which price they remained steady until the 16th, being kept firm by a scarcity of stock. The following week shares were very flat, and on the 19th had fallen to 27l.-27½l., about which price they remained till the close of the week. On the 23rd they opened firmer, and on the 24th, on the report of the discovery of a new lode, they advanced to 29½l.-30l. This price, however, has not been maintained, for shares have since declined to 28½l.-29l. A very considerable amount of discontent has been expressed by the London dealers at the delay on the part of the agent of this mine in forwarding intelligence of the last improvement in the mine, which was made on the Friday, but not made known in London until the Monday following; although large purchases of shares are alleged to have been made in the meantime by those who had received earlier information. At a special meeting on the 25th, the members of the Mining Exchange passed resolutions demanding an enquiry, and directing the mine to be forthwith inspected on their behalf by Captain Charles Thomas, of Dolcoath.

*Clifford Amalgamated* shares steadily advanced from the end of last month up to the 26th, when they had gone up nearly 10l., but close flatter at a slight decline. They opened 27l.-28l. on the 30th, and gradually crept up to 32¼l.-32¾l. on the 19th, after which they advanced rapidly to their highest point 37l.-39l., on the 25th. On the 26th they relapsed 1l. to 36l½l.-37½l., and close 36l.-37l. *Clijah and Wentworth*, 7l.-8l. *North Buller*, 6½l.-7l. *North Grambler*, 3¾l.-4l. *Nanjiles* shares were quoted 21½l. on the 18th and rapidly advanced several pounds, but on the 25th they declined to 27l., and close 22l.-26l.

*East Basset* shares had, at one time, partially recovered their decline of last month. They opened 77½l.-78½l. *ex. div.*, and on the 14th had advanced to 80l.-81l., but close flatter at 78l.-80l. *South Frances*, 70l.-72½l. *West Basset*, 11l.-12l. *West Frances*, 17l.-19l. *Wheal Basset*, 60l.-65l. *North Basset*, 3⅛l.-3⅜.

*Tincroft* shares have not maintained their opening prices, having declined about 30s. per share, from 21½l.-22l. to 20l.-21l. *Cook's Kitchen* have been dull through the month at 25l.-26l., and declined on the 25th to 24l.-25l. *Illogan Consols*, 1¼l.-1½l. *Stray Park* shares have been flat and declined from 40l.-41l. to 38½l.-39½l. *Wheal Agar*, 2⅝l.-2⅞l. *Wheal Harriett*, 1¾l.-2¼l.

*North Crofty* shares close, as they opened, at 3¾l.-4l., having been in the meantime flatter. *Wheal Crofty*, 3¼l.-3¾l., a new lode having been cut in the 34 cross-cut, worth 25l. per fm. *South Crofty*, 20l.-21l. *North Roskear*, 23l.-24l. *Roskearnoweth*, 3l.-4l.

*East Carn Brea*, which opened at 7¾l.-8¼l., sprang into demand about the 20th, and advanced to 8⅜l.-8⅝l., have again relapsed and close flat at 7¾l.-8¼l. *South Carn Brea*, 1¾l.-2¼l. *Wheal Union*, 3l.-3¼l. *Wheal Uny*, 5½l.-5¾l. *Great South Tolgus*, 3½l.-3¾l. *North Downs* shares have receded from 2⅛l.-2⅜l. to 1¾l.-2l. There has been a fair amount of business doing in *Wheal Kitty* (*St. Agnes*), which have been tolerably firm at from 7¾l.-8¼l. to 8⅝l.-8⅞l. They close 8¼l.-8½l.

*Great Wheal Fortune* shares have been very flat all the month, and have declined steadily, closing 28l.-29l., or 6l. lower the opening quotations. *Calvadnack*, 6l.-7l. At the beginning of the month *Basset and Grylls* shares were in demand, and advanced from 22½l.-23½l. to 23½.-24½l., but on the 5th relapsed 10s., and have since remained at 23l.-24l. *Wheal Grylls* has receded, shares having dropped from 29l.-30l. to 27l.-29l. *Great Wheal Vor*, 7⅛l. *Wendron Consols*, 9l.-10l.

*East Russell* shares had declined from 4½l. to 3l.-3¼l., but finally rallied to 3⅜l.-3⅝l. *New Wheal Martha* have declined from 3½l.-3¾l. to 2½l.-3l. *North Robert*, 12s. 6d.-15s. *Drakewalls*, 1½l. to 1¾l. *East Gunnis Lake and South Bedford*, 27s. 6d.-32s. 6d. *Hinston Down*, 2l.-2¼l. *Wheal Crebor*, shares have been neglected, and have declined to 1⅜l.-1⅞l. *Wheal Edward*

$2\frac{5}{8}l.$-$2\frac{7}{8}l.$ *Kelly Bray*, 15s.-17s. 6d. *Lady Bertha*, 10s.-15s. *Bottle Hill*, 15s.-16s. *Devon Great Consols* have been in steady demand and have changed hands at prices ranging from 560l. to 580l.

*Herodsfoot* shares have been more offered, and close flat at $28\frac{1}{2}l$-29l. *Wheal Ludcott and Wrey* shares are a trifle better, being quoted at 3l.-$3\frac{1}{4}l.$, or an improvement of 7s. 6d. on their opening prices. *Trelawny*, 16l.-17l. *Wheal Mary Ann* shares have declined from $12\frac{1}{2}l.$-$13\frac{1}{2}l.$ to 12l.-13l. *South Herodsfoot*, 3l.-4l.

*Wheal Grenville*, 6l.-$6\frac{1}{2}l.$, has been quiet, with scarcely any alteration in price. *East Grenville* shares are a shade better, at $3\frac{1}{2}l.$-$3\frac{3}{4}l.$ *Wheal Unity*, 14s.-16s. *North Dolcoath*, $2\frac{1}{8}l.$-$2\frac{3}{8}l.$ *West Trevelyan*, 7s.-9s.

*Providence* shares enquired for about the middle of the month at 41l.-42l., and close 42l.-43l. *Wheal Margaret* shares were enquired for on the 4th, at 32l.-33l., but they have since become flatter and close at 30l.-31l. *Rosewall* and *Ransom United*, $2\frac{3}{4}l.$-3l. *Pendeen Consols*, $6\frac{1}{2}l.$-$6\frac{3}{4}l.$

*West Chiverton* shares continue to advance, having improved 4l. per share during the month. They opened 26l.-27l. and close 30l.-31l. *Cargoll*, 40l.-45l. *Chiverton*, 7l.-$7\frac{1}{4}l.$ *East Chiverton*, $4\frac{3}{4}l.$-$5\frac{1}{4}l.$ *Wheal Hope*, 2l.-$2\frac{1}{4}l.$

*Marke Valley* shares receded from 6l.-$6\frac{1}{4}l.$ to $5\frac{3}{4}l.$-6l. *Gonamena* shares have advanced from $1\frac{7}{8}l.$-$2\frac{1}{8}l.$ to $2\frac{3}{4}l.$-$2\frac{3}{4}l.$ *Glasgow Caradon Consols* have improved 10s., from $3\frac{1}{4}l.$ to $3\frac{3}{4}l.$ *South Caradon*, 115l.-120l. *West Caradon*, 23l.-24l.

The price of *Wheal Seton* has remained comparatively steady this month, but no great amount of business has been doing. Shares opened $217\frac{1}{2}l.$-220l., and on the 10th advanced to $222\frac{1}{2}l.$-$227\frac{1}{2}l.$, but have again declined to 210l.-220l. *South Tolgus*, 40l.-42l. *West Tolgus*, 55l.-60l. *West Seton*, 237l.

In Welsh mines the following prices are quoted: *Bryn Gwiog*, 34l.-35l. *Billins*, 18l.-19l. *Long Rake*, $4\frac{1}{2}l.$-$4\frac{3}{4}l.$

In foreign and colonial mines, business has been transacted as follows:—At the beginning of the month *Cobre Copper* shares improved 1l. per share, to 30l., but again relapsed to $29\frac{1}{2}l.$, at which they close. *Cape Copper*, $4\frac{1}{8}l.$ *Don Pedro North Del Rey*, 1l. *St. John Del Rey* shares opened at 55l., and improved to 57l., but again relapsed, and close at 56l. *Santa Barbara*, 12s. 6d. *Linares* shares have advanced 10s., and close at $7\frac{1}{2}l.$ *Mariquita* were flat at the beginning of the month, but towards the middle were inquired for, and close, as they opened, at 12s. 6d. *East Del Rey*, 12s. 6d. *Montes Aureos* shares have receded 5s., opening $2\frac{1}{4}l.$ and closing 2l. *Vallanzasio* have been flat, and declined 7s. 6d., closing at 17s. 6d. *Scottish Australian*, 15s. *Capula Silver*, 15s. *Port Phillip*, dull at $1\frac{1}{4}l.$-$1\frac{3}{8}l.$ *Capunda*, 17s. 6d. *Alamillos* flat at 10s. *United Mexican* shares inquired for at $6\frac{3}{4}l.$ *Yudanamutana* shares opened at $3\frac{1}{4}l.$-$3\frac{3}{8}l.$, and fluctuated till the 17th, when they fell to $2\frac{1}{2}l.$-$2\frac{3}{4}l.$, at which price they remained for a few days, and then slightly improved; they close $3\frac{1}{4}l.$-$3\frac{1}{2}l.$ Among new concerns, *Kyffhäuser Mining and Smelting* were quoted $\frac{1}{2}$-1l. prem. *New Mansfeld*, $\frac{1}{2}$-$\frac{3}{4}$ prem.

DUBLIN. The amount of business doing in the Irish mine share market has been almost nominal. *Wicklow Copper* shares are quoted nominally at 40l., but there are no transactions at that price, holders being firm. *Mining Company of Ireland* shares have done at former quotations, 19l. 2s. 6d. *Connoree* shares, after having slightly rallied, close at 16s. 6d.

CORNWALL. The Cornish share market has participated in the prevailing dullness, and the amount of business transacted has been trifling. *South Crofty* has receded 2l. 10s. per share, and *Great Fortune*, 5l. *West Jane* has advanced from 17s.-19s. to 24s.-25s. *Gurlyn*, 30s. *Trelyon Consols*, 12l. *Sithney Carnmeal*, 5l.-$5\frac{1}{2}l.$ *Carn Brea*, 65l.-66l. *East Wheal Lovel*, $3\frac{1}{2}l.$-4l. *East Rosewarne*, $2\frac{1}{4}l.$-$2\frac{3}{4}l.$

## METAL MARKETS.

LONDON, *August 27th.*—The metal market was dull in the early part of the month, but at the close prices generally have been better.

IRON.—The iron trade has been pretty active, and a fair amount of business has been transacted.

Scotch pig-iron has advanced from 52*s.* 10*d.* to 54*s.* 3*d.*

Welsh bars, which opened dull at 5*l.* 10*s.* in Wales, have become firmer, and have advanced to 6*l.* 5*s.* in Wales, and 7*l.* f. o. b. in London. Staffordshire descriptions have been in demand, and steady at full prices. Swedish bars have been quoted at 11*l.* 10*s.*, but very little business has been done in them.

STEEL.—Prices of Swedish have been very firm with an upward tendency, but transactions have been very limited.

COPPER.—This metal has been decidedly dull; and English, both raw and manufactured, was to be obtained under official prices, and very difficult of sale. Business in foreign has been much restricted: Burra Burra, 98*l.* 10*s.* to 99*l.* Kapunda, 100*l.* Spanish, 90*l.*

YELLOW METAL.—This article has been in little demand; braziery sheets, 8½*d.*; sheathing, 9*d.*

TIN.—The market for English continues very flat, and on the 10th smelters again reduced the price 4*l.* per ton on refined, and 3*l.* on common, making present prices 120*l.* for refined, and 115*l.* for common. This reduction has had a depressing effect on foreign, and Straits can now be obtained at 118*l.* Banca, nominal 124*l.* The Dutch market has been very flat at 73½ fl.

TIN PLATES.—This article has been in fair demand, and prices have been maintained.

LEAD.—This article has been dull of sale. Good soft English, 20*l.* to 20*l.* 5*s.*

SPELTER.—Considerable business has been done in this article at 18*l.* 7*s.* 6*d.* to 18*l.* 10*s.* on the spot, and 18*l.* 10*s.* to 18*l.* 15*s.* for forward delivery. Hull parcels, 18*l.* to 18*l.* 2*s.* 6*d.*

GLASGOW, *August 20th.* IRON.—The pig-iron market has been very quiet all through the month, but prices have slightly improved from 52*s.* 6*d.* to 54*s.* The exports last month were 47,173 tons, against 47,544 tons during the corresponding period of last year—showing a decrease of 371 tons.

BERLIN, *August 15th.*—The metal market here has been pretty active, although prices have not altered much.

IRON.—Scotch pig-iron has been considerably dealt in, and prices close slightly higher. Iron in bars, 3⅞ to 4 thlrs. Staffordshire descriptions, 5 thlrs.

TIN.—This article has been very quiet and in little demand. Banca, 46 thlrs. English, 40 thlrs.

COPPER.—The market for this metal has been firm, although the amount of business transacted has been inconsiderable. Burra Burra, 34 thlrs.; English, 32 to 32½ thlrs.; Demidoff, 36 thlrs.; Paschkoff, 38 thlrs.; Mansfield refined, 34 thlrs.

LEAD.—This article has been firm and in request, particularly for export to Russia.

SPELTER.—The market for this metal continues firm, W. H. 5½ thlrs.

HAMBURG, *August 13th.*—There is little change to note in the metal market here. Transactions have been limited, although on the whole prices have been maintained.

IRON.—Scotch pig-iron has been quoted at 2⅝ to 2¾ mk. Iron in bars, 5 to 5⅛ mk. Staffordshire descriptions, 5⅞ to 6⅛ mk.

COPPER.—This article has been more in demand and prices have been firmly maintained. English sheathing, 71 mk.; Lake Superior, 68 mk.; Demidoff, 71 mk.

YELLOW METAL.—English in sheets has been quoted at 56 mk.

TIN.—The market in this metal continues very quiet, and prices are merely nominal. English in blocks, 13¼ sch. Banca in blocks, 14½ sch.

SPELTER.—After a long interval of dulness this article has again sprung into demand, and business has been transacted at 11 mk.

BRESLAU, *August 15th.* SPELTER.—The market for this metal is very firm, anda large business has been done at 5 thlrs. 9½ sgr.

LÜTTICH, *August 14th.* IRON.—The market for this metal continues very quiet, but prices seem to have an upward tendency.

AMSTERDAM, *August 15th.* TIN.—Banca has been very quiet, and has declined to 73½ fl., but at this price seems to attract more attention.

COPPER.—Very little business has been transacted in this metal.

COLOGNE, *August 17th.*—There has been rather more business transacted in the metal market, and prices have been fairly maintained. Copper has been firmer, but tin has considerably declined. Lead and spelter show an upward tendency.

PARIS, *August 15th.* COPPER.—The market for this metal has been firm, although no great amount of business done. English, 240 fr. Chili, 227½ fr. Lake Superior, 270 fr.

TIN.—This metal has been reduced 5 fr. English has been quoted at 300 fr. Banca, 335 fr. Straits, 325 fr.

LEAD.—This article remains unaltered at 54¼ to 55 fr.

HONG KONG, *July 12th.* LEAD.—Sales at $7-$7 25c. per picul.

IRON.—There is no alteration in value. Sales about 4,300 piculs.

AMOY, *June 30th.* LEAD.—450 pigs, $7 60c.-$7 80c.

FOOCHOW, *July 7th.* LEAD.—1,320 piculs, at $8 50c.

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*Furnished by Von Dadelszen and North,* 158, *Leadenhall Street, London, E.C.*

The metal market this month has presented but few features of interest, although the unusual dullness which prevailed at the commencement has been succeeded by a better feeling; more business has been done, and in several cases higher prices are now obtainable.

IRON.—Welsh bars are very firm at from 6*l.* to 6*l.* 5*s.* f.o.b. in Wales, and from 6*l.* 15*s.* to 7*l.* f.o.b. here. Staffordshire qualities are in good demand at the recent official advance of 10*s.* per ton. Scotch pigs have improved somewhat, closing 54*s.* cash, and 54*s.* 9*d.* three months open; an advance of 6*d.* per ton.

COPPER.—The market remains very dull, and this metal is easily obtainable at from 1*l.* to 30*s.* under official quotations; very few orders have been given out for manufactured. Nothing of consequence has been done in foreign. We quote Burra, 98*l.* 10*s.*; Kapunda, 100*l.*; Spanish, 90*l.*

TIN.—This market is very flat. Straits, 117*l.* cash, 118*l.* three months, and 120*l.* afloat. Banca nominally 124*l.* English is obtainable below official prices.

TIN PLATES are in improved demand for common coke qualities. Charcoals remain flat.

LEAD very dull; 20*l.* to 20*l.* 5*s.* good soft English.

SPELTER.—This metal has improved more than 10*s.* per ton during the month; 18*l.* 10*s.* is now demanded for spot parcels here, and in Hull, 18*l.* 7*s.* 6*d.*; forward 18*l.* 10*s.* to 18*l.* 15*s.*

## PRICES CURRENT OF METALS.

From Messrs. JAMES and SHAKSPEARE'S, 10, Austin Friars, E.C., *28th August.*

| | | | | | |
|---|---|---|---|---|---|
| | | | Per Ton. | | |
| IRON .......... | Bars (Welch) .. in Wales .. | £6 0 0 | @ | £6 5 0 |
| | " " .. " Liverpool | 6 10 0 | " | 6 12 6 |
| | " " .. " London | 6 15 0 | " | 7 0 0 |
| | Nail Rods " .. " Wales . | 6 10 0 | " | 6 15 0 |
| | " (Staffordshire) " Liverpool | 7 5 0 | " | 7 12 6 |
| | " " " London | 7 15 0 | " | 8 0 0 |
| | Hoops " " Liverpool | 8 5 0 | " | 8 12 6 |
| | " " " London | 8 15 0 | " | 9 0 0 |
| | Sheets " " Liverpool | 9 5 0 | " | 9 12 6 |
| | " " " London | 9 15 0 | " | 10 0 0 |
| | Bars " " Liverpool | 7 5 0 | " | 7 12 6 |
| | " " " London | 7 15 0 | " | 8 0 0 |
| | Scotch Pig (No. 1. g.m.b.) the Clyde | 2 13 0 | " | 2 13 6 |
| | Rails ................ in Wales | 6 0 0 | " | 6 5 0 |
| | Swedish—Hammered—large sizes | 11 5 0 | " | 11 10 0 |
| | " " Indian assortments | —— | " | 11 10 0 |
| STEEL ........ | " " Hammered—faggot | 16 10 0 | " | 17 0 0 |
| | " " in kegs (¼ and ⅝ in.) | 15 10 0 | " | 16 0 0 |
| COPPER ...... Australian .. | Burra and P.C.C. ............ | 99 0 0 | " | 100 0 0 |
| | Kapunda .................. | —— | " | 100 0 0 |
| | Wallaroo .................. | —— | " | 98 0 0 |
| American.... | Baltimore .................. | 98 0 0 | " | 100 0 0 |
| | Lake Superior .............. | —— | " | none |
| | Spanish Cake................ | 91 0 0 | " | 92 0 0 |
| | Chili and other Slab (for 96 per cent. pure Copper) ........ | —— | " | 87 0 0 |
| English .... | Tough Cake and Ingot and Tile | —— | " | 95 0 0 |
| | Best selected Ingot .......... | —— | " | 98 0 0 |
| | Sheets, Sheathing and Rod .... | —— | " | 102 0 0 |
| | Flat Bottoms................ | —— | " | 107 0 0 |
| | | | Per lb. | | |
| YELLOW METAL.. | Sheets .................... | 8*d.* | @ | 8¼*d.* |
| | Sheathing and Rod ........ | 8¾*d.* | " | 9*d.* |
| | | | Per Cwt. | | |
| TIN ......... English .. | Common Blocks and Ingots .... | —— | @ | 115*s.* |
| | " Bars (in barrels) ...... | —— | " | 116*s.* |
| | Refined .................... | —— | " | 120*s.* |
| Foreign .. | Straits, Fine .................. | —— | " | 117*s.* |
| | " (with 3 months' prompt) | 118*s.* | " | 119*s.* |
| | Banca .................... | 125*s.* | " | 126*s.* |
| | | | Per Box. | | |
| TIN PLATES at Liverpool 6*d.* Less | Charcoal IC, best.............. | 28*s.* 6*d.* | @ | 29*s.* |
| | " IX " ............. | 34*s.* 6*d.* | " | 35*s.* |
| | Coke IC .................. | 23*s.* | " | 25*s.* |
| | " IX .................. | 29*s.* | " | 31*s.* |
| | | | Per Ton. | | |
| LEAD........ English .. | Sheet ...................... | —— | @ | £20 15 0 |
| | Pig—W.B. .................. | —— | " | 21 7 6 |
| | " Other good brands ........ | 20 0 0 | " | 20 5 0 |
| | " German and Spanish, soft .. | —— | " | 19 10 0 |
| English .. | Red ...................... | —— | " | 21 10 0 |
| | Shot ...................... | —— | " | 23 10 0 |
| | Dry White.................. | —— | " | 26 0 0 |
| SPELTER ...... | (Silesian) in Cakes ............ | —— | " | 18 5 0 |
| ZINC .......... | (Sheet) No. 9 and upwards .... | —— | " | 23 5 0 |
| | | | Per Bottle. | | |
| QUICKSILVER | (in bottles containing 75lbs. each) | —— | @ | 7 0 0 |
| | | | Per Ton. | | |
| REGULUS OF ANTIMONY. | French Star ...... | —— | @ | 39 0 0 |

# Tabular Abstract of Mining Accounts for the Month.

| Date of Account. | Name of Mine, and Number of Shares. | Balances. Debit. | Balances. Credit. | Calls. Per Share. | Calls. Total. | Dividends. Per Share. | Dividends. Total. |
|---|---|---|---|---|---|---|---|
| | **CORNISH AND DEVON MINES.** | £ s. d. | £ s. d. | £ s. d | £ s. d. | £ s. d. | £ s. d. |
| July 23 | West Chiverton (3,000) | — | 2,353 5 10 | — | — | — | — |
| " 23 | Lady Bertha (6,000) | — | 145 13 1 | 0 3 6 | 1,050 0 0 | — | — |
| " 23 | South Phœnix (5.325) | 601 10 10 | — | 0 2 0 | 532 10 0 | — | — |
| " 23 | North Jane (2,000) | — | 129 7 10 | — | — | — | — |
| " 24 | Devon Great Consols (1,024) | — | 31,554 6 9 | — | — | 9 0 0 | 9,216 0 0 |
| " 27 | Copper Hill (1,024) | — | 360 5 9 | — | — | — | — |
| " 27 | North Great Work (6,000) | — | 118 7 8 | — | — | — | — |
| " 28 | South Caradon (512) | — | 4,328 1 4 | — | — | 5 0 0 | 2,560 0 0 |
| " 28 | Penhalls (6,000) | 689 2 8 | — | — | — | — | — |
| " 28 | Wheal Kitty (St. Agnes) (429) | — | 904 7 6 | — | — | — | — |
| " 28 | South Tolgus (512) | — | 151 9 1 | — | — | — | — |
| " 29 | West Basset (6,000) | — | 1,562 9 6 | — | — | 0 5 0 | 1,500 0 0 |
| " 29 | Prosper United (6,000) | 4,732 0 2 | — | — | — | — | — |
| " 29 | Trencrom (1,024) | 411 1 4 | — | — | — | — | — |
| " 29 | Wheal Agar (6,000) | 668 6 6 | — | 0 8 0 | 2,400 0 0 | — | — |
| " 29 | Goonbarrow & Moliness (6,400) | — | 797 10 5 | — | — | | |
| " 29 | West Jane (10,000) | 2,154 16 2 | — | 0 5 0 | 2,500 0 0 | — | — |
| " 30 | Gonamena (6,144) | — | 198 17 1 | 0 2 6 | 768 0 0 | — | — |
| " 30 | Craddock Moor (1,055) | — | 937 12 11 | — | — | — | — |
| " 30 | Trevenen and Tremenheere (5.600) | 1,222 13 5 | — | 0 4 0 | 1,120 0 0 | — | — |
| " 30 | North Dolcoath (5,000) | 656 0 0 | — | 0 10 0 | 2,500 0 0 | — | — |
| " 31 | Great Devon and Bedford (10,000) | — | 2,576 4 7 | — | — | — | — |
| Aug. 3 | North Robert (6,144) | — | 337 8 2 | 0 2 6 | 768 0 0 | — | — |
| " 5 | North Pool (6,400) | — | 117 8 9 | 0 10 0 | 3,200 0 0 | — | — |
| " 5 | South Caradon Wheal Hooper (4,096) | 238 8 8 | — | 0 2 0 | 409 12 0 | — | — |
| " 5 | East Grenville (6,000) | 474 0 0 | — | 0 1 0 | 300 0 0 | — | — |
| " 6 | South Seton (400) | 624 10 1 | — | 2 10 0 | 1,000 0 0 | — | — |
| " 6 | Wheal Crebor (6,000) | 500 0 0 | — | 0 2 0 | 600 0 0 | — | — |
| " 7 | Wheal Arthur (5,998) | 221 13 10 | — | 0 2 6 | 749 15 0 | — | — |
| " 7 | Charlotte United (5,785) | 2,201 0 0 | — | 0 7 7 | 2,193 9 7 | — | — |
| " 7 | West Frances (512) | 1,172 0 0 | — | 2 10 0 | 1,280 0 0 | — | — |
| " 7 | Great Fortune (1,798) | — | 2,070 9 11 | — | — | 0 15 0 | 1,348 10 0 |
| " 10 | Dolcoath (358) | — | 3,536 0 0 | — | — | 8 0 0 | 2,864 0 0 |
| " 11 | West Seton (400) | — | 3,157 6 0 | — | — | 5 0 0 | 2,000 0 0 |
| " 12 | Wheal Polmear (1,024) | — | 492 10 5 | — | — | — | — |
| " 12 | St. Ives Wheal Allen (1,024) | 561 0 0 | — | 0 10 11 | 568 18 8 | — | — |
| " 12 | North Crofty (5,610) | 236 5 2 | — | 0 1 6 | 420 15 0 | — | — |
| " 12 | East Seton (5,610) | — | 91 18 7 | — | — | — | — |
| " 12 | North Frances (2,500) | — | — | 0 2 6 | 312 10 0 | — | — |
| " 13 | Cargoll (916) | — | 1,032 0 10 | — | — | — | — |
| " 14 | Wheal Tremayne (2,844) | — | 1,206 16 7 | — | — | 1 0 0 | 1,022 0 0 |
| " 18 | Wheal Rose (2,000) | 1,963 0 0 | — | 1 5 0 | 2,500 0 0 | — | — |
| " 18 | Wheal Par (1,024) | 1,055 0 0 | — | 1 0 0 | 1,024 0 0 | — | — |
| " 19 | Clifford Amalgamated (2,900) | — | 2,087 11 11 | — | — | 0 12 6 | 1,812 10 0 |
| " 19 | Wheal Unity Consols (6,000) | 1,221 16 5 | — | — | — | — | — |
| " 19 | Wheal Sithney Carnmeal (2,048) | 1,309 11 5 | — | 0 13 0 | 1,331 4 0 | — | — |
| " 20 | Wheal Grenville (6,000) | 267 5 10 | — | 0 1 0 | 300 0 0 | — | — |
| " 20 | East Russell (4,000) | — | 486 12 0 | 0 2 6 | 500 0 0 | — | — |
| " 25 | North Buller (1,024) | 293 0 0 | — | 0 12 6 | 640 0 0 | — | — |
| | **WELSH & OTHER MINES.** | | | | | | |
| July 23 | Aberffrwd (6,000) | 285 0 0 | — | 0 4 0 | 1,200 0 0 | — | — |
| " 30 | South Darren (6,000) | 38 14 5 | — | 0 2 6 | 750 0 0 | — | — |
| " 30 | Long Rake (2,000) | 656 0 0 | — | 0 10 0 | 1,000 0 0 | — | — |
| " 31 | Billins (400) | 900 0 0 | — | — | — | — | — |
| " 31 | East Dyliffe (1,200) | — | 780 12 10 | — | — | — | — |
| Aug. 4 | Byrntail (1,861) | 155 2 9 | — | — | — | — | — |
| " 14 | Harwood (6,400) | — | 91 10 5 | — | — | — | — |
| " 24 | Bronfloyd United (3,000) | — | 1,278 11 11 | — | — | 0 2 6 | 625 0 0 |
| | **FOREIGN MINES.** | | | | | | |
| June 3 | Burra Burra (2,464) | — | — | — | — | 6 0 0 | 12,320 0 0 |
| " 27 | Port Phillip and Colonial (100,000) | — | — | — | — | 0 1 0 | 5,000 0 0 |
| July 24 | South Europe (15,000) | — | 2,813 17 9 | — | — | 0 2 6 | 1,875 0 0 |
| Aug. 21 | Yudanamutana (45,000) | — | 26,284 0 0 | — | — | 0 5 0 | 11,250 0 0 |

# Copper Ores.

**Sampled July 15, and sold at the Royal Hotel, Truro, July 30.**

| Mines. | Tons. | Purchasers. | Price. | Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|---|---|---|---|
| South Caradon | 88 | 6, 7 | £5 15 6 | West Caradon | 63 | 8 | £6 16 0 |
| | 79 | 9 | 8 7 0 | | 57 | 1, 5, 6 | 8 12 6 |
| | 74 | 7 | 9 0 0 | | 53 | 1 | 6 3 6 |
| | 73 | 3, 9 | 17 18 0 | | 39 | 1 | 8 9 6 |
| | 44 | 11 | 5 19 6 | | 35 | 1 | 4 7 6 |
| | 43 | 6 | 8 15 6 | Fowey Consols | 77 | 1, 5 | 6 10 0 |
| | 42 | 1, 5 | 1 13 6 | | 75 | 6 | 5 2 6 |
| | 38 | 3, 7 | 19 5 6 | | 73 | 1 | 7 1 6 |
| | 30 | 7 | 6 2 6 | | 65 | 1 | 5 18 6 |
| Clifford Amalgamated | 98 | 3 | 4 9 6 | North Downs | 64 | 14 | 6 14 0 |
| | 77 | 7 | 3 6 6 | | 53 | 3 | 5 14 6 |
| | 61 | 2 | 5 1 0 | | 42 | 14 | 6 12 6 |
| | 60 | 12 | 2 19 6 | | 29 | 8 | 2 6 6 |
| | 35 | 1 | 7 18 6 | Craddock Moor | 67 | 1, 6 | 5 18 0 |
| | 28 | 10 | 4 12 0 | | 59 | 9 | 5 10 0 |
| | 27 | 7 | 3 17 0 | | 41 | 1 | 1 0 0 |
| | 26 | 12 | 1 6 6 | Wheal Rose | 68 | 7 | 4 14 0 |
| | 18 | 10 | 3 6 6 | | 65 | 12 | 5 15 6 |
| Great Wheal Busy | 63 | 6, 13 | 2 0 6 | Wheal Polmear | 50 | 10 | 4 1 6 |
| | 62 | 9 | 2 10 6 | | 40 | 2 | 5 2 0 |
| | 55 | 5 | 2 17 6 | | 25 | 1, 10, 13 | 5 6 6 |
| | 51 | 5 | 1 18 6 | St. Day United | 48 | 3 | 4 10 0 |
| | 50 | 11 | 3 11 6 | | 24 | 8 | 1 16 6 |
| | 43 | 7 | 2 8 6 | Molland | 50 | 14 | 6 3 6 |
| | 41 | 8, 9 | 3 10 6 | Bampfylde | 43 | 1, 5 | 12 5 0 |
| | 35 | 11 | 5 8 0 | Perran Mines | 27 | 1 | 5 14 6 |
| | 21 | 5 | 3 18 0 | | 1 | 1 | 5 0 0 |
| North Treskerby | 65 | 2 | 5 0 0 | Burra Burra | 28 | 9 | 3 0 6 |
| | 61 | 6 | 4 18 0 | Boscawen | 28 | 12 | 5 18 6 |
| | 60 | 6, 13 | 4 16 0 | Treffry's Regulus | 17 | 1, 5 | 9 19 0 |
| | 59 | 2 | 5 18 0 | Wheal Prudence | 10 | 1 | 4 0 0 |
| | 58 | 5 | 5 6 0 | | 6 | 1 | 4 0 0 |
| | 56 | 7, 13 | 4 10 0 | Wheal Damsel | 9 | 1 | 3 12 6 |
| | 51 | 5, 7 | 4 7 6 | Brown's Ore | 3 | 5 | 1 14 6 |
| West Caradon | 73 | 8 | 4 10 0 | Pembroke | 2 | 8 | 3 10 6 |
| | 65 | 8 | 4 10 0 | | | | |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| South Caradon | 511 | £4,749 1 6 | Molland | 50 | £308 15 0 |
| Clifford Amalgamated | 430 | 1,782 17 0 | Bampfylde | 43 | 526 15 0 |
| Great Wheal Busy | 421 | 1,238 17 6 | Perran Mines | 28 | 159 11 6 |
| North Treskerby | 410 | 2,042 10 6 | Burra Burra | 28 | 84 14 0 |
| West Caradon | 385 | 2,351 19 0 | Boscawen | 28 | 165 18 0 |
| Fowey Consols | 290 | 1,786 9 6 | Treffry's Regulus | 17 | 169 8 0 |
| North Downs | 188 | 1,077 18 0 | Wheal Prudence | 16 | 64 0 0 |
| Craddock Moor | 167 | 760 16 0 | Wheal Damsel | 9 | 32 12 6 |
| Wheal Rose | 133 | 694 19 6 | Brown's Ore | 3 | 5 3 6 |
| Wheal Polmear | 115 | 540 17 6 | Pembroke | 2 | 7 1 0 |
| St. Day United | 72 | 259 16 0 | | | |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Vivian and Sons | 544½ | £3,326 7 6 | 9 Copper Miners' Co. | 285 | £1,941 17 9 |
| 2 Freeman and Co. | 225 | 1,185 3 0 | 10 Charles Lambert | 104½ | 343 1 6 |
| 3 Grenfell and Sons | 254½ | 1,968 8 6 | 11 Newton, Keates & Co. | 129 | 630 13 0 |
| 4 Crown Copper Co. | — | —— | 12 Sweetland, Tuttle & Co. | 179 | 754 4 6 |
| 5 Sims, Willyams & Co. | 322 | 1,559 11 9 | 13 Neath Copper Co. | 97 5-6 | 378 3 0 |
| 6 Williams, Foster & Co. | 337 | 1,884 0 3 | 14 Penclawdd Copper Co. | 156 | 1,015 16 0 |
| 7 Mason and Elkington | 435½ | 2,491 9 9 | | | |
| 8 Bankart and Sons | 276½ | 1,259 18 9 | Total | 3,346 | £18,809 15 6 |

Average Produce, 7¼.
Quantity of Fine Copper, 241 tons 19 cwts.

Average Standard ... £115 15 0
Average price per ton ... 5 12 0

# Copper Ores.

**Sampled July 22, and sold at Tyack's Hotel, Camborne, Aug. 6.**

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| Clifford Amalgamated | 103 | 7 | £3 | 7 | 6 |
| | 101 | 1 | 6 | 16 | 6 |
| | 92 | 3 | 6 | 12 | 0 |
| | 88 | 9 | 4 | 18 | 0 |
| | 79 | 6 | 3 | 8 | 6 |
| | 76 | 5 | 6 | 9 | 0 |
| | 61 | 9 | 4 | 3 | 0 |
| | 60 | 3 | 4 | 2 | 0 |
| | 52 | 10 | 3 | 8 | 0 |
| | 42 | 5 | 5 | 5 | 0 |
| | 41 | 6 | 6 | 17 | 6 |
| | 35 | 12 | 2 | 13 | 6 |
| | 30 | 1 | 6 | 7 | 6 |
| | 26 | 10 | 4 | 19 | 0 |
| (Consols) | 68 | 2 | 5 | 3 | 6 |
| West Seton ............ | 80 | 9 | 6 | 6 | 6 |
| | 76 | 6 | 2 | 14 | 6 |
| | 65 | 1 | 7 | 6 | 6 |
| | 64 | 8 | 5 | 11 | 6 |
| | 62 | 3 | 5 | 9 | 6 |
| | 58 | 9 | 6 | 18 | 0 |
| | 56 | 12 | 5 | 8 | 6 |
| | 48 | 5 | 7 | 15 | 0 |
| | 47 | 8 | 3 | 19 | 6 |
| | 43 | 7 | 2 | 8 | 0 |
| | 24 | 7 | 6 | 19 | 6 |
| Wheal Seton ............ | 38 | 3 | 5 | 5 | 6 |
| (Pendarves) | 104 | 10 | 1 | 6 | 6 |
| | 92 | 3, 7 | 4 | 7 | 6 |
| | 82 | 2, 3, 6 | 5 | 12 | 0 |
| | 53 | 7 | 5 | 9 | 0 |
| | 19 | 5 | 12 | 12 | 0 |
| East Pool ............... | 82 | 9 | 3 | 14 | 0 |
| | 61 | 7 | 3 | 14 | 0 |
| | 60 | 1 | 0 | 3 | 0 |
| | 59 | 7 | 3 | 7 | 0 |

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| East Pool ............... | 47 | 7 | £3 | 2 | 6 |
| Wheal Grenville ...... | 64 | 1, 5 | 9 | 5 | 0 |
| | 32 | 13 | 6 | 1 | 6 |
| | 31 | 1 | 5 | 12 | 6 |
| | 26 | 5 | 9 | 7 | 6 |
| | 24 | 5 | 3 | 9 | 6 |
| | 23 | 8 | 7 | 5 | 0 |
| Wheal Basset ......... | 72 | 5 | 4 | 10 | 6 |
| | 65 | 13 | 4 | 14 | 6 |
| | 32 | 9 | 8 | 9 | 6 |
| | 19 | 7 | 12 | 6 | 6 |
| South Frances ......... | 64 | 1, 6 | 5 | 18 | 6 |
| | 57 | 7, 9 | 6 | 8 | 6 |
| | 30 | 1 | 8 | 18 | 0 |
| | 24 | 5, 8 | 4 | 18 | 0 |
| Dolcoath ............... | 92 | 10 | 4 | 18 | 6 |
| | 45 | 6 | 5 | 17 | 6 |
| South Tolgus ......... | 77 | 3 | 5 | 18 | 0 |
| | 51 | 3, 5, 13 | 3 | 5 | 0 |
| East Basset ............ | 60 | 9 | 7 | 13 | 6 |
| | 22 | 7 | 16 | 0 | 0 |
| | 21 | 9 | 6 | 10 | 0 |
| Tincroft .................. | 49 | 5, 10, 12 | 2 | 3 | 6 |
| | 36 | 12 | 5 | 5 | 6 |
| | 2 | 5 | 25 | 15 | 0 |
| Stray Park............... | 60 | 6, 13 | 3 | 18 | 6 |
| East Grenville ......... | 41 | 1 | 4 | 4 | 6 |
| | 14 | 5 | 2 | 6 | 6 |
| North Roskear ......... | 50 | 1 | 8 | 13 | 6 |
| South Crofty............ | 19 | 7 | 2 | 7 | 6 |
| | 14 | 2 | 6 | 11 | 0 |
| Camborne Vean ...... | 20 | 3 | 4 | 7 | 0 |
| Condurrow ............ | 16 | 12 | 5 | 4 | 0 |
| Illogan Mines ......... | 5 | 8 | 5 | 0 | 6 |
| Sarah's Ore ............ | 2 | 1 | 3 | 3 | 6 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Clifford Amalgamated...... | 954 | £4,779 | 18 | 6 |
| West Seton..................... | 623 | 3,418 | 18 | 0 |
| Wheal Seton .................. | 388 | 1,728 | 4 | 0 |
| East Pool ...................... | 309 | 882 | 12 | 6 |
| Wheal Grenville ............ | 200 | 1,454 | 13 | 6 |
| Wheal Basset.................. | 188 | 1,138 | 6 | 0 |
| South Frances ............... | 175 | 1,130 | 0 | 6 |
| Dolcoath......................... | 137 | 717 | 9 | 6 |
| South Tolgus.................. | 128 | 620 | 1 | 0 |
| East Basset..................... | 103 | 949 | 0 | 0 |
| Tincroft ............................ | 87 | £347 | 19 | 6 |
| Stray Park ...................... | 60 | 235 | 10 | 0 |
| East Grenville ................. | 55 | 205 | 15 | 6 |
| North Roskear.................. | 50 | 433 | 15 | 0 |
| South Crofty ................... | 33 | 136 | 16 | 6 |
| Camborne Vean ............... | 20 | 87 | 0 | 0 |
| Condurrow ....................... | 16 | 83 | 4 | 0 |
| Illogan Mines .................. | 5 | 25 | 2 | 6 |
| Sarah's Ore ..................... | 2 | 6 | 7 | 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| 1 Vivian and Sons ......... | 474 | £2,906 | 0 | 0 |
| 2 Freeman and Co.......... | 109½ | 596 | 13 | 4 |
| 3 Grenfell and Sons ...... | 439½ | 2,343 | 19 | 4 |
| 4 Crown Copper Co. ...... | — | —— | | |
| 5 Sims, Willyams & Co. | 383½ | 2,449 | 8 | 6 |
| 6 Williams, Foster & Co. | 347½ | 1,539 | 11 | 4 |
| 7 Mason and Elkington ... | 524½ | 2,492 | 19 | 6 |
| 8 Bankart and Sons ...... | 151 | 794 | 6 | 0 |
| 9 Copper Miners' Co. ...... | 510½ | £2,945 | 5 | 6 |
| 10 Charles Lambert ......... | 290½ | 931 | 18 | 6 |
| 11 Newton, Keates & Co. ... | — | —— | | |
| 12 Sweetland, Tuttle & Co. | 159½ | 706 | 1 | 0 |
| 13 Neath Copper Co. ...... | 144 | 674 | 10 | 6 |
| 14 Penclawdd Copper Co. | — | —— | | |
| Total ............... | 3,533 | £18,380 | 13 | 6 |

Average Produce, 6⅝.
Quantity of Fine Copper, 235 tons 15 cwts.

Average Standard ..................£119 4 0
Average Price per ton ............ 5 4 0

# Copper Ores.

Sampled July 29, and sold at Tabb's Hotel, Redruth, Aug. 13.

| Mines. | Tons. | Purchasers. | Price. | Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|---|---|---|---|
| West Basset ............ | 73 | 6, 10 | £4 4 6 | Treloweth ............... | 24 | 1, 5 | £11 4 6 |
| | 71 | 13 | 5 5 6 | | 23 | 2 | 5 12 0 |
| | 70 | 7, 10 | 5 3 6 | Great South Tolgus...... | 63 | 9 | 9 14 0 |
| | 56 | 1, 5 | 11 15 0 | | 47 | 6, 13 | 7 11 6 |
| | 55 | 3 | 7 17 6 | Wheal Anna ............ | 105 | 6 | 6 3 0 |
| | 42 | 5 | 6 1 0 | Rosewarne Consols...... | 47 | 5 | 6 13 0 |
| | 40 | 3 | 6 19 6 | | 38 | 2, 5 | 6 6 0 |
| | 37 | 5 | 8 9 0 | | 19 | 5 | 3 6 0 |
| | 34 | 5 | 3 17 0 | Botallack.................. | 51 | 1, 9 | 10 2 6 |
| | 22 | 7 | 3 18 6 | | 47 | 5 | 3 18 0 |
| Carn Brea ................ | 85 | 12 | 3 1 6 | Copper Hill ............ | 59 | 14 | 2 7 6 |
| | 78 | 9 | 3 14 0 | | 36 | 1 | 9 14 6 |
| | 60 | 7, 9 | 7 5 6 | Pendeen Consols......... | 58 | 5 | 3 7 0 |
| | 46 | 9 | 3 4 6 | | 12 | 5 | 2 2 6 |
| | 24 | 10 | 1 8 6 | Rosewarne United ...... | 31 | 1 | 9 12 6 |
| Par Consols ............ | 66 | 1 | 7 19 0 | | 25 | 7 | 2 11 0 |
| | 61 | 3 | 7 8 0 | | 10 | 7 | 2 16 0 |
| | 60 | 3 | 7 8 0 | Wheal Buller............ | 55 | 5, 7 | 3 3 0 |
| | 58 | 1 | 1 16 0 | | 10 | 7 | 14 15 6 |
| | 37 | 10 | 4 0 6 | Prideaux Wood ......... | 58 | 8 | 2 11 6 |
| Levant ..................... | 85 | 7 | 7 17 0 | Treworlis .................. | 28 | 12 | 0 14 6 |
| | 63 | 7 | 4 16 6 | | 16 | 1 | 3 8 6 |
| | 60 | 9 | 5 11 0 | | 10 | 8 | 0 1 6 |
| | 54 | 1 | 0 15 0 | East Alfred Consols...... | 25 | 5, 12 | 3 17 6 |
| | 2 | 5 | 14 2 0 | Wheal Trannack......... | 13 | 1 | 1 17 6 |
| Prosper United......... | 70 | 6 | 4 13 0 | | 8 | 1 | 3 5 6 |
| | 56 | 8 | 1 11 0 | | 2 | 1 | 0 3 0 |
| | 39 | 2 | 4 17 6 | South Buller......... ... | 18 | 12, 13 | 3 1 6 |
| | 19 | 5 | 5 7 0 | | 3 | 1 | 11 5 0 |
| Alfred Consols ......... | 61 | 3 | 5 5 0 | South Dolcoath............ | 16 | 1, 5 | 15 8 6 |
| | 49 | 7 | 1 17 6 | Great Wheal Alfred...... | 14 | 12 | 3 0 6 |
| | 32 | 9 | 6 10 0 | Camborne Consols ...... | 11 | 9 | 6 6 6 |
| | 21 | 9 | 3 19 0 | New Rosewarne ......... | 7 | 9 | 4 2 6 |
| East Carn Brea......... | 49 | 3 | 5 15 6 | | 4 | 1 | 11 15 6 |
| | 39 | 5 | 5 14 6 | James's Ore .............. | 4 | 1 | 5 8 6 |
| | 38 | 3 | 5 6 6 | Trevenen's Ore........... | 2 | 8 | 4 1 0 |
| Treloweth.................. | 73 | 6 | 4 6 0 | | 1 | 12 | 13 13 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| West Basset .................. | 500 | £3,199 6 6 | Rosewarne United........... | 66 | £390 2 6 |
| Carn Brea ..................... | 293 | 1,169 0 6 | Wheal Buller .................. | 65 | 321 0 0 |
| Par Consols .................. | 282 | 1,673 8 6 | Prideaux Wood .............. | 58 | 149 7 0 |
| Levant........................... | 264 | 1,372 18 6 | Treworlis ........................ | 54 | 75 17 0 |
| Prosper United ............... | 194 | 704 1 6 | East Alfred ..................... | 25 | 96 17 6 |
| Alfred Consols............... | 163 | 703 1 6 | Trannack ......... ........... | 23 | 50 17 6 |
| East Carn Brea............... | 126 | 708 12 0 | South Buller .................. | 21 | 89 2 0 |
| Treloweth ..................... | 120 | 712 2 0 | South Dolcoath ............... | 16 | 246 16 0 |
| Great South Tolgus......... | 110 | 967 2 6 | Great Wheal Alfred ......... | 14 | 42 7 0 |
| Wheal Anna.................. | 105 | 645 15 0 | Camborne Consols............ | 11 | 69 11 6 |
| Rosewarne Consols ......... | 104 | 614 13 0 | New Rosewarne ............ | 129 | 75 19 6 |
| Botallack ........................ | 98 | 699 13 6 | James's Ore .................. | 4 | 21 14 0 |
| Copper Hill .................. | 95 | 490 4 6 | Trevenen's Ore ............... | 3 | 21 15 0 |
| Pendeen Consols............... | 70 | 219 16 0 | | | |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Vivian and Sons ............ | 568½ | £2,371 11 9 | 9 Copper Miners' Co. ... | 373¾ | £2,246 17 9 |
| 2 Freeman and Co. ......... | 81 | 438 12 6 | 10 Charles Lambert......... | 182¾ | 518 9 3 |
| 3 Grenfell and Sons ......... | 364 | 2,413 2 0 | 11 Newton, Keates & Co. | — | —— |
| 4 Crown Copper Co. ......... | — | —— | 12 Sweetland, Tuttle & Co. | 149¾ | 413 15 9 |
| 5 Sims, Willyams & Co. ... | 364 | 2,670 19 9 | 13 Neath Copper Co. ...... | 101¼ | 580 4 3 |
| 6 Williams, Foster & Co. ... | 308 | 1,617 7 6 | 14 Penclawdd Copper Co. | 59 | 140 2 6 |
| 7 Mason and Elkington ... | 356½ | 1,874 19 0 | | | |
| 8 Bankart and Sons ... ..... | 126 | 245 0 0 | Total.............. | 2,885 | £15,531 2 0 |

Average Produce, 6¾.
Quantity of Fine Copper, 197 tons 18 cwts.

Average Standard .................. £118 11 0
Average Price per ton ............ 5 8 0

# Copper Ores.

**Sampled Aug. 5, and sold at the Royal Hotel, Truro, Aug. 20.**

| Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|
| Devon Great Consols | 135 | 6, 9 | £4 9 6 |
| | 132 | 1 | 4 12 6 |
| | 131 | 1, 6 | 4 14 6 |
| | 130 | 6 | 5 6 6 |
| | 127 | 2 | 4 14 0 |
| | 126 | 3 | 5 10 0 |
| | 125 | 11 | 4 1 0 |
| | 121 | 3 | 4 15 6 |
| | 119 | 7 | 4 10 0 |
| | 118 | 10 | 4 7 0 |
| | 117 | 3, 7 | 4 6 6 |
| | 114 | 6, 7 | 4 10 0 |
| | 113 | 5 | 11 16 0 |
| | 111 | 10 | 1 1 0 |
| | 108 | 9 | 4 9 0 |
| | 100 | 3, 8 | 4 15 6 |
| | 98 | 5 | 4 11 6 |
| | 97 | 1 | 4 12 6 |
| | 96 | 9 | 4 12 6 |
| | 90 | 12 | 2 6 0 |
| | 53 | 1 | 9 14 6 |
| East Caradon | 90 | 1 | 4 18 6 |
| | 82 | 1 | 4 7 6 |
| | 70 | 1, 6 | 8 15 6 |
| | 68 | 6 | 6 13 6 |
| | 66 | 6 | 4 16 6 |
| | 64 | 1 | 5 16 6 |
| | 62 | 1, 6 | 6 1 0 |
| Phœnix Mines | 98 | 7 | 2 9 6 |
| | 84 | 7 | 4 17 6 |
| | 78 | 7 | 4 19 0 |
| | 65 | 7 | 3 3 0 |
| | 68 | 12 | 2 18 6 |
| | 57 | 6 | 3 14 6 |
| Marke Valley | 88 | 10 | 3 4 0 |
| Marke Valley | 81 | 10, 12 | £3 3 6 |
| | 80 | 13 | 3 4 0 |
| | 74 | 1 | 3 13 6 |
| | 47 | 10 | 2 10 6 |
| | 31 | 3 | 7 3 6 |
| Devon and Cornwall | 94 | 12 | 2 1 0 |
| | 85 | 10 | 1 1 6 |
| | 61 | 7 | 4 12 6 |
| Bedford United | 108 | 6, 13 | 3 15 0 |
| | 97 | 9 | 4 16 6 |
| Wheal Emma | 56 | 10 | 1 18 0 |
| | 34 | 3 | 5 18 6 |
| | 25 | 1 | 1 3 6 |
| | 20 | 10 | 3 5 0 |
| Yarner Mine | 107 | 5 | 2 14 6 |
| Wheal Crebor | 106 | 7, 10 | 3 5 6 |
| Brookwood | 75 | 1 | 4 4 6 |
| | 30 | 1 | 6 17 0 |
| North Wheal Robert | 56 | 9 | 0 12 6 |
| | 44 | 6 | 6 13 0 |
| Crelake | 62 | 3 | 3 17 6 |
| | 38 | 10 | 2 9 6 |
| Wheal Arthur | 61 | 7, 9 | 4 14 0 |
| | 29 | 5, 10 | 1 11 0 |
| Wheal Friendship | 45 | 1, 6 | 8 10 6 |
| | 31 | 1, 6 | 7 5 6 |
| Gunnis Lake (Clitters) | 45 | 14 | 4 17 6 |
| Sortridge Consols | 22 | 6, 9 | 3 13 0 |
| | 15 | 14 | 7 13 6 |
| Collacombe | 36 | 1 | 2 7 6 |
| Hawkmoor | 29 | 3, 9 | 4 14 6 |
| South Bedford | 25 | 7 | 2 18 6 |
| Fursdon | 25 | 5 | 4 4 0 |
| Geach's Ore | 3 | 3 | 7 9 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. |
|---|---|---|
| Devon Great Consols | 2,361 | £11,439 1 0 |
| East Caradon | 502 | 2,936 10 0 |
| Phœnix Mines | 445 | 1,639 10 0 |
| Marke Valley | 401 | 1,407 16 6 |
| Devon and Cornwall | 240 | 566 4 0 |
| Bedford United | 205 | 873 0 6 |
| Wheal Emma | 135 | 402 4 6 |
| Yarner | 107 | 291 11 6 |
| Crebor | 106 | 347 3 0 |
| Brookwood | 105 | 522 7 6 |
| North Robert | 100 | 327 12 0 |
| Crelake | 100 | £334 6 0 |
| Wheal Arthur | 90 | 331 13 0 |
| Wheal Friendship | 76 | 609 3 0 |
| Gunnis Lake (Clitters) | 45 | 219 7 6 |
| Sortridge Consols | 37 | 195 8 6 |
| Collacombe | 36 | 85 10 0 |
| Hawkmoor | 29 | 137 0 6 |
| South Bedford | 25 | 66 17 6 |
| Fursdon | 25 | 105 0 0 |
| Geach's Ore | 3 | 22 7 0 |

## EACH COMPANY'S PURCHASE.

| | | Tons. | Amount. |
|---|---|---|---|
| 1 | Vivian and Sons | 928¼ | £4,767 5 9 |
| 2 | Freeman and Co. | 127 | 569 18 0 |
| 3 | Grenfell and Sons | 500 | 2,517 10 6 |
| 4 | Crown Copper Co. | — | — |
| 5 | Sims, Willyams & Co. | 414¼ | 2,413 2 6 |
| 6 | Williams, Foster & Co. | 667 | 3,667 3 0 |
| 7 | Mason and Elkington | 676 | 2,780 5 3 |
| 8 | F. Bankart | 103 | 412 6 6 |
| 9 | Copper Miners' Co. | 480¼ | £1,981 14 0 |
| 10 | Charles Lambert | 671 | 1,711 11 9 |
| 11 | Newton, Keates & Co. | 125 | 506 5 0 |
| 12 | Sweetland, Tuttle & Co. | 287¼ | 712 11 3 |
| 13 | Neath Copper Co. | 134 | 458 10 0 |
| 14 | Penclawdd Co. | 60 | 334 10 0 |
| | Total | 5,173 | £22,859 13 6 |

Average Produce, 5⅝.
Quantity of Fine Copper, 298 tons 2 cwts.

Average standard ........................£124 8 0
Average Price per ton .............. 4 8 0

# Copper Ores.

**Sampled July 8, and sold at Swansea, July 28.**

| Mines. | Tons. | Produce. | Purchasers. | Price. £ | s. | d. |
|---|---|---|---|---|---|---|
| Cobre | 86 | 13¾ | 3 | £11 | 3 | 0 |
| | 49 | 23 | 3 | 20 | 0 | 0 |
| | 48 | 23 | 3 | 19 | 15 | 0 |
| | 46 | 23⅝ | 3 | 20 | 0 | 0 |
| | 33 | 33⅞ | 8 | 28 | 5 | 0 |
| | 98 | 12⅝ | 10 | 10 | 12 | 6 |
| | 96 | 12⅝ | 10 | 10 | 12 | 6 |
| | 93 | 13⅛ | 6 | 10 | 14 | 0 |
| | 92 | 12⅞ | 7 | 10 | 15 | 0 |
| | 86 | 13¼ | 7, 9 | 10 | 19 | 6 |
| | 63 | 19¾ | 3 | 16 | 6 | 0 |
| | 57 | 19 | 15 | 16 | 1 | 6 |
| | 12 | 53⅛ | 8 | 44 | 10 | 6 |
| | 10 | 52⅝ | 8 | 43 | 15 | 6 |
| Berehaven | 100 | 10 | 5, 9 | 8 | 6 | 6 |
| | 80 | 10¼ | 6 | 8 | 3 | 0 |
| | 132 | 10¼ | 6 | 8 | 6 | 0 |
| | 111 | 9¾ | 6 | 8 | 5 | 0 |
| | 118 | 10⅝ | 6, 13 | 8 | 5 | 0 |
| Union | 95 | 7 | 6 | 5 | 3 | 0 |
| | 87 | 6¾ | 6 | 5 | 5 | 0 |
| | 84 | 6½ | 6 | 4 | 18 | 0 |

| Mines. | Tons. | Produce. | Purchasers. | Price. £ | s. | d. |
|---|---|---|---|---|---|---|
| Union | 21 | 5¼ | 6 | £4 | 7 | 0 |
| Yudanamutana | 21 | 32¼ | 5, 13, 14 | 28 | 5 | 0 |
| | 48 | 33¼ | 13 | 27 | 12 | 0 |
| | 34 | 30¾ | 3 | 27 | 12 | 0 |
| | 47 | 33¼ | 5 | 26 | 16 | 6 |
| | 46 | 36¼ | 1, 8 | 28 | 0 | 6 |
| Fortune (West Australia) | 67 | 22¼ | 5 | 18 | 15 | 6 |
| | 31 | 21½ | 2 | 17 | 17 | 0 |
| Gourock | 6 | 6⅛ | 16 | 4 | 14 | 6 |
| | 6 | 7¼ | 2 | 5 | 18 | 0 |
| Bathurst | 8 | 21⅛ | 2 | 17 | 6 | 0 |
| Gourock | 3 | 6¼ | 16 | 5 | 13 | 0 |
| | 12 | 8¼ | 16 | 5 | 4 | 6 |
| Holyford | 3 | 9½ | 5 | 5 | 17 | 6 |
| Australian | 2 | 19¼ | 5 | 15 | 7 | 0 |
| Knockmahon | 62 | 8¼ | 7, 13 | 7 | 7 | 6 |
| | 65 | 10¼ | 5 | 9 | 6 | 0 |
| Seville Ore | 32 | 7¼ | 7 | 5 | 9 | 0 |
| Lisbon | 68 | 25¼ | 7 | 21 | 3 | 0 |
| | 4 | 10⅛ | 2 | 9 | 5 | 0 |
| | 18 | 4¼ | 2, 3 | 3 | 15 | 0 |
| | 1 | 26⅝ | 2 | 21 | 14 | 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. |
|---|---|---|
| Cobre | 169 | £12,643 11 6 |
| Knockmahon | 541 | 4,469 0 0 |
| Union | 541 | 1,448 19 0 |
| Yudanamutana | 196 | 5,406 7 6 |
| Fortune | 98 | 1,811 5 6 |
| Gourock | 12 | 63 15 0 |
| Bathurst | 8 | 138 8 0 |
| Gourock | 15 | £79 13 0 |
| Holyford | 3 | 23 8 0 |
| Australian | 2 | 30 14 0 |
| Knockmahon | 127 | 1,033 17 0 |
| Seville Ore | 32 | 174 8 0 |
| Lisbon | 91 | 1,564 8 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. |
|---|---|---|
| 1 Copper Miners Co. | 23 | £644 11 6 |
| 2 Freeman and Co. | 59 | 819 12 0 |
| 3 P. Grenfell and Sons | 335 | 5,805 19 0 |
| 4 Crown Copper Co. | — | —— |
| 5 Sims, Willyams, Nevill & Co. | 241 | 3,763 8 0 |
| 6 Vivian and Sons | 762 | 5,594 3 0 |
| 7 Williams, Foster & Co. | 266 | 3,302 3 0 |
| 8 British and For. Copper Co. | 78 | 2,548 17 6 |
| 9 Mason and Elkington | 93 | 888 3 6 |
| 10 Bankart and Sons | 194 | £2,061 5 0 |
| 11 Charles Lambert | — | —— |
| 12 Ravenhead Copper Co. | — | —— |
| 13 Sweetland, Tuttle & Co. | 145 | 2,237 18 6 |
| 14 Jennings and Co. | 7 | 197 15 0 |
| 15 Neath Copper Co. | 57 | 916 5 6 |
| 16 Penclawdd Copper Co. | 21 | 108 0 0 |
| Total | 2,281 | £28,888 1 6 |

# Black Tin Sales.

| Date. | Mines. | Tons | c. | q. | lbs. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| July 20. | Kitty (St. Agnes) | 17 | 17 | 0 | 14 | — | | | — | 1258 | 6 | 9 |
| „ 25. | Gurlyn | 2 | 13 | 2 | 6 | 68 | 12 | 6 | Chyandour | 183 | 15 | 0 |
| | Polhigey Moor | 1 | 9 | 3 | 23 | 67 | 10 | 0 | Calenic Co. | 114 | 16 | 11 |
| | „ | 0 | 6 | 3 | 14 | 40 | 0 | 0 | ditto | | | |
| „ 28. | Cuddra | 4 | 2 | 0 | 21 | 68 | 0 | 0 | Enthoven & Sons | 289 | 4 | 3 |
| | „ | 0 | 3 | 3 | 18 | 50 | 0 | 0 | ditto | | | |
| „ 29. | Great Wheal Busy | 17 | 2 | 2 | 2 | — | | | — | 1062 | 5 | 0 |
| | Great Wheal Fortune | 15 | 16 | 3 | 3 | — | | | Chyandour | 1189 | 5 | 6 |
| | West Beam | 10 | 10 | 0 | 8 | 74 | 4 | 0 | Truro Co. | 779 | 7 | 3 |
| | East Lovell | 5 | 17 | 0 | 10 | 71 | 0 | 0 | Chyandour | 516 | 13 | 6 |
| | „ | 2 | 8 | 0 | 13 | 42 | 0 | 0 | ditto | | | |
| | Treworlis | 5 | 10 | 3 | 6 | 66 | 0 | 0 | ditto | 389 | 4 | 6 |
| | „ | 0 | 9 | 3 | 8 | 48 | 0 | 0 | ditto | | | |
| Aug. 6. | Leeds & St. Aubyn | 4 | 1 | 0 | 11 | 71 | 0 | 0 | ditto | 287 | 18 | 0 |
| | Great Wheal Fortune | 16 | 9 | 0 | 5 | — | | | Mellanear | 1229 | 6 | 11 |
| „ 8. | Bottle Hill | 1 | 10 | 0 | 0 | 68 | 5 | 0 | Charlestown | 204 | 15 | 0 |
| | „ | 1 | 10 | 0 | 0 | 68 | 5 | 0 | Truro Co. | | | |
| | Kitty (St. Agnes) | 20 | 7 | 1 | 4 | — | | | — | 1366 | 11 | 6 |
| „ 13. | Gt. Wheal Vor United | 27 | 12 | 2 | 18 | — | | | — | 1980 | 6 | 1 |
| | Penhalls | 3 | 9 | 2 | 6 | — | | | — | 240 | 16 | 6 |
| „ 15. | Pedn-an-drea | 10 | 19 | 2 | 23 | — | | | Carvedras | 722 | 13 | 0 |
| „ 17. | Gurlyn | 7 | 3 | 3 | 10 | 67 | 12 | 5 | Chyandour | 486 | 7 | 0 |

# Copper Ores.

**Sampled July 22, and sold at Swansea August 11.**

| Mines. | Tons. | Produce. | Purchasers. | Price. | | |
|---|---|---|---|---|---|---|
| Berehaven | 75 | 10 | 3, 6 | £8 | 2 | 0 |
| | 78 | 10⅛ | 1 | 8 | 3 | 6 |
| | 95 | 11⅛ | 7 | 9 | 11 | 6 |
| | 77 | 10¾ | 7 | 9 | 7 | 0 |
| | 131 | 11⅞ | 6 | 9 | 12 | 0 |
| | 80 | 11⅝ | 13 | 9 | 12 | 0 |
| | 71 | 11⅛ | 13 | 9 | 11 | 6 |
| | 105 | 11¾ | 5 | 9 | 14 | 0 |
| Cobre | 93 | 12¼ | 3, 6 | 10 | 1 | 0 |
| | 92 | 12 | 9 | 10 | 1 | 0 |
| | 96 | 12⅛ | 6 | 9 | 16 | 0 |
| | 100 | 12¼ | 3 | 10 | 0 | 6 |
| | 96 | 12⅛ | 3, 7 | 10 | 1 | 6 |
| | 37 | 32½ | 2 | 28 | 15 | 0 |
| Knockmahon | 100 | 11⅛ | 1, 6 | 9 | 16 | 0 |
| | 90 | 11⅛ | 5 | 9 | 17 | 0 |
| | 95 | 10⅛ | 6, 7 | 8 | 19 | 0 |
| Knockmahon | 80 | 11⅝ | 1, 3, 6 | £9 | 7 | 0 |
| | 43 | 11⅝ | 6 | 9 | 10 | 0 |
| Chili | 65 | 17⅞ | 2 | 15 | 4 | 6 |
| | 64 | 18⅛ | 10 | 15 | 10 | 6 |
| | 63 | 18⅛ | 1 | 15 | 14 | 6 |
| | 62 | 18¾ | 5 | 15 | 18 | 6 |
| | 60 | 25 | 7 | 21 | 18 | 0 |
| | 35 | 27 | 6 | 22 | 15 | 0 |
| | 17 | 22¼ | 15 | 19 | 9 | 0 |
| French Slag | 28 | 10⅛ | 5 | 7 | 14 | 0 |
| Cape Copper | 24 | 38⅛ | 13 | 33 | 10 | 6 |
| New South Wales | 11 | 11⅛ | 5 | 9 | 9 | 6 |
| South Australia | 5 | 30⅝ | 5 | 25 | 16 | 0 |
| Black Copper | 5 | 59⅛ | 10 | 51 | 11 | 6 |
| Reading | 5 | 5⅛ | 10 | 3 | 15 | 0 |
| Union | 2 | 21⅛ | 5 | 18 | 18 | 0 |

TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Berehaven | 712 | £6,598 | 13 | 0 |
| Cobre | 509 | 5,784 | 10 | 0 |
| Knockmahon | 408 | 3,873 | 5 | 0 |
| Chili | 366 | 6,402 | 3 | 0 |
| French Slag | 28 | 215 | 12 | 0 |
| Cape Copper | 24 | 804 | 12 | 0 |
| New South Wales | 11 | £104 | 4 | 6 |
| South Australia | 5 | 129 | 0 | 0 |
| Black Copper | 5 | 257 | 17 | 6 |
| Reading | 5 | 18 | 15 | 0 |
| Union | 2 | 37 | 16 | 0 |

EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| 1 Copper Miners' Co. | 217¾ | £2,367 | 13 | 2 |
| 2 Freeman and Co. | 102 | 2,053 | 7 | 6 |
| 3 Grenfell and Sons | 258¾ | 2,506 | 10 | 2 |
| 4 Crown Copper Co. | — | — | | |
| 5 Sims, Willyams, Nevill & Co. | 303 | 3,378 | 19 | 6 |
| 6 Vivians and Sons | 600½ | 6,214 | 5 | 8 |
| 7 Williams, Foster & Co. | 327¾ | 3,852 | 6 | 0 |
| 8 British and For. Copper Co. | — | — | | |
| 9 Mason and Elkington | — | — | | |
| 10 Bankart and Sons | 74 | £1,270 | 4 | 6 |
| 11 Charles Lambert | — | — | | |
| 12 Ravenhead Copper Co. | — | — | | |
| 13 Sweetland, Tuttle & Co. | 175 | 2,252 | 8 | 6 |
| 14 Jennings & Co. | — | — | | |
| 15 Neath Copper Co. | 17 | 330 | 13 | 0 |
| 16 Penclawdd Copper Co. | — | — | | |
| Total | 2,075 | £24,226 | 8 | 0 |

# Sundry Copper Ore Sales.

| Date. | Mines. | Tons. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|
| Aug. 14. | West Canada (ex Ravenna) | 60 | 17 | 7 | 6 | C. Lambert<br>Evans & McBryde | | | |
| | ” ” | 60 | 17 | 7 | 6 | ditto | | | |
| | ” ” | 60 | 17 | 7 | 6 | ditto | 6,705 | 10 | 0 |
| | ” ” | 50 | 17 | 8 | 6 | C. Lambert | | | |
| | ” ” | 80 | 17 | 9 | 6 | ditto | | | |
| | ” ” | 75 | 17 | 9 | 0 | ditto | | | |
| | Knockmahon (ex Enterprise) | 65 | 10 | 13 | 6 | Newton, Keates & Co. | | | |
| | ” ” | 65 | 10 | 14 | 6 | Bibby, Sons & Co. | 1,958 | 0 | 0 |
| | ” (West Docks) | 70 | 4 | 1 | 0 | C. Lambert | | | |
| | ” ” | 70 | 4 | 1 | 0 | Newton, Keates & Co. | | | |
| | Italian (ex Corinthian) | 5 | 11 | 3 | 6 | Bibby, Sons & Co. | 284 | 0 | 6 |
| | ” ” | 13 | 17 | 11 | 0 | Evans & McBryde | | | |

# Lead Ore Sales.

| Dates. | | Mines. | Tons. | Price per Ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|
| July | 29. | Dyliffe | 45 | 12 | 9 | 0 | Walker, Parker & Co. | 1058 | 5 | 0 |
| | | ,, | 40 | 12 | 9 | 0 | ditto | | | |
| ,, | 31. | Minera | 105 | 13 | 6 | 0 | Sims, Willyams & Co. | 7054 | 10 | 0 |
| | | ,, | 105 | 13 | 6 | 0 | ditto | | | |
| | | ,, | 100 | 13 | 6 | 0 | ditto | | | |
| | | ,, | 110 | 13 | 6 | 6 | ditto | | | |
| | | ,, | 110 | 13 | 6 | 6 | ditto | | | |
| Aug. | 3 | East Logylas | 80 | 12 | 6 | 0 | Panther Co. | 984 | 0 | 0 |
| | | Glogfach | 60 | 16 | 4 | 6 | Walker, Parker & Co. | 811 | 5 | 0 |
| | | Cwmystwith | 100 | 12 | 11 | 6 | ditto | 1257 | 10 | 0 |
| | | Goginan | 22 | 16 | 10 | 6 | Newton, Keates & Co. | 554 | 8 | 0 |
| | | ,, | 11 | 17 | 7 | 0 | Sims, Willyams & Co. | | | |
| ,, | 5. | Dyliffe | 55 | 12 | 10 | 6 | Newton, Keates & Co. | 688 | 17 | 6 |
| ,, | 6. | Isle of Man Mining Co. | 100 | 22 | 4 | 0 | Sima, Willyams & Co. | 2650 | 15 | 0 |
| | | ,, | 30 | 14 | 12 | 6 | Treffry's Trustees | | | |
| | | Wheal Mary Ann | 44 | 24 | 0 | 0 | R. Michell and Son | 2190 | 12 | 6 |
| | | ,, | 35 | 15 | 5 | 6 | Treffry's Trustees | | | |
| | | North Laxey | 12 | 13 | 3 | 0 | Sims, Willyams & Co. | 159 | 0 | 0 |
| | | Bronfloyd United | 50 | 12 | 18 | 0 | Panther Co | 645 | 0 | 0 |
| ,, | 8. | Minera Union | 15 | 12 | 10 | 0 | Sims, Willyams & Co. | 187 | 10 | 0 |
| ,, | 13. | Talargoch (Maesyrerwddu) | 53½ | 13 | 11 | 0 | Newton, Keates & Co. | 1845 | 10 | 3 |
| | | ,, (Coetia Llys) | 78½ | 14 | 5 | 6 | Walker, Parker & Co. | | | |
| | | Deep Level | 10 | 12 | 3 | 6 | ditto | 121 | 15 | 0 |
| | | Rhosesmor | 76 | 13 | 1 | 6 | A. Eyton | 1974 | 6 | 6 |
| | | ,, | 75 | 13 | 1 | 6 | ditto | | | |
| | | Parry's | 36 | 13 | 5 | 6 | Walker, Parker & Co. | 477 | 18 | 0 |
| | | Bryn Gwiog | 50 | 13 | 4 | 6 | ditto | 661 | 5 | 0 |
| | | Long Rake | 20 | 13 | 0 | 6 | Newton, Keates & Co. | 260 | 10 | 0 |
| | | Speedwell | 9 | 12 | 1 | 6 | ditto | 108 | 13 | 6 |
| | | Holywell | 8 | 14 | 11 | 6 | Walker, Parker & Co. | 142 | 11 | 0 |
| | | ,, | 2 | 12 | 19 | 6 | A. Eyton | | | |
| | | Merllyn | 3 | 11 | 18 | 0 | Newton, Keates & Co. | 35 | 14 | 0 |
| | | Garreg | 2 | 12 | 15 | 0 | ditto | 25 | 10 | 0 |
| | | Llangynog United | 20½ | 12 | 1 | 0 | ditto | 494 | 1 | 0 |
| | | ,, | 20½ | 12 | 1 | 0 | Walker, Parker & Co. | | | |
| | | Llanerchyraur | 14 | 13 | 1 | 0 | Newton, Keates & Co. | 182 | 14 | 0 |
| ,, | 17. | Frongoch | 40 | 12 | 3 | 6 | Panther Co. | 487 | 0 | 0 |
| | | West Frongoch | 12 | 12 | 3 | 6 | ditto | 292 | 4 | 0 |
| | | ,, | 12 | 12 | 3 | 6 | Walker, Parker & Co. | | | |
| | | Gwaithcoch | 20 | 11 | 15 | 0 | ditto | 235 | 0 | 0 |
| | | East Darren | 80 | 15 | 15 | 0 | Treffry's Trustees | 1260 | 0 | 0 |
| | | Cwmerfin | 25 | 15 | 15 | 0 | ditto | 955 | 10 | 0 |
| | | ,, | 35 | 16 | 1 | 0 | ditto | | | |
| ,, | 19. | Dyliffe | 38 | 12 | 11 | 0 | Walker, Parker & Co. | 476 | 18 | 0 |
| | | Llanerchyraur | 13 | 13 | 2 | 6 | ditto | 170 | 12 | 6 |
| | | Dyfngwym | 27 | 12 | 5 | 6 | Newton, Keates & Co. | 331 | 8 | 6 |

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British Columbia.—From advices received up to the 22nd of June, it appears that the quartz mining interest in Cariboo was creating excitement. The older rich companies were doing so well as to maintain their reputation, and a new quartz vein had been struck near Deep Creek, which produced rich specimens. William's Creek, from which such immense quantities have been obtained, still continues to yield largely, and will most likely be the centre of the Cariboo district for some years. The value put upon mining property, may be inferred from the fact that one share in the *Cariboo Company* sold for $9,750, although the mine was undeveloped, the value being attained by the character of the neighbouring claims. Altogether everything seems to bid fair for a successful mining season, and prospects generally are very cheering.

THE

# MINING AND SMELTING MAGAZINE.

OCTOBER, 1863.

## On the Occurrence of Titanium in Pig Iron, and some Remarks on the Use of Titaniferous Minerals in the Manufacture of Iron and Steel.

BY EDWARD RILEY, F.C.S., LATE CHEMIST TO THE DOWLAIS IRON WORKS.

THE presence of small cubical red crystals, with a metallic lustre, has long been observed in the hearths of old blast-furnaces—they may be said, in fact, to be universally present to a greater or less extent—occurring most largely in the hearths of furnaces where clay ironstone, or silicious iron ores (such as the red hematite and Forest of Dean ores) are used. The crystals are always more abundant when the furnaces are used for making the best grey iron, the most perfect crystals that have come under the author's observation being some from the Low Moor ironworks; while the largest quantity were from the ironworks in the Forest of Dean, and the Pontypool ironworks, some of which crystals were massed together, and had the appearance of copper. The iron from the above works has a great commercial reputation for its quality, and as a rule the better the quality of iron made in a blast-furnace the more titanium is found in the hearths.

The examination of a large number of the hearths of the Welsh blast-furnaces, where common iron for rails and bars is chiefly made;—in one works eighteen were inspected during their removal;—the crystals were observed disseminated through the mass, but were only very small in size and minute in quantity.

The red crystals were first supposed by Wollaston to be titanium; but Wöhler has subsequently shown them to be a mixture of a nitride and cyanide of titanium, containing 18 % of nitrogen and 4 % of carbon. The composition of the crystals, however, varies—as some will be found to be readily converted into titanic acid on boiling with strong nitric acid, whereas others are quite unattacked by this re-agent.

Until recently the source of these crystals has not been very clearly accounted for, as in all analyses of materials used in the blast-furnace, titanic acid or the oxide of titanium was very rarely if ever mentioned. Titanic acid has hitherto been considered an oxide occurring only in minute quantity, or found in minerals that are not largely disseminated—such as in Rutile and Anatase, in the pure or

nearly pure state, in Iserine, Ilmenite, and numerous other minerals, mostly mixed with a large percentage of iron. The following are two analyses of some Norwegian ore that has been used in the blast-furnace, and will be subsequently referred to:—

| | 1. | 2. |
|---|---|---|
| Magnetic oxide of iron .. .. .. | 46·14* | 54·72 |
| Titanic acid .. .. .. .. | 36·88 | 40·80 |
| Silica .. .. .. .. .. | 13·32 | 1·58 |
| Magnesia .. .. .. .. .. | 2·07 | 2·13 |
| Lime .. .. .. .. .. | ·78 | ·66 |
| Bisulphide of iron (iron pyrites) .. | 1·05 | — |
| | 100·24 | 99·89 |
| Metallic iron .. .. .. .. | 33·39 | 39·62 |

No phosphoric acid was detected.

An experience of eleven years, in the almost exclusive examination of ores and products from iron works, has proved to me that titanium ought no longer to be considered one of the rarer elements, as it occurs very generally disseminated, and is a universal constituent of all clays, as was pointed out by me in a paper read before the Chemical Society last year, and recently published, from which the following table is extracted—giving the percentage of titanium in the principal fire bricks used in London. The methods adopted to determine titanium are not at all satisfactory; the following results would certainly be too low rather than too high, as in all probability the whole of the titanic acid was not obtained.

TABLE showing the amount of Titanic Acid in Fire Bricks and Clay. A complete analysis of these bricks was not made, except those of Dowlais, and the Titanic Acid is too low and only represents in part the amount present.

| Description of Brick. | Silica. | Titanic Acid. |
|---|---|---|
| | % | % |
| Stourbridge (Slickman) .. .. | 65·11 | 1·05 |
| " (Rufford) .. .. | 63·42 | 1·05 |
| Newcastle (Lucas) .. .. .. | 60·49 | ·60 |
| " (Stephenson) .. .. | 60·60 | ·42 |
| " (Ramsay) .. .. .. | 55·86 | ·67 |
| Wortley Leeds (Ingham) .. .. | 62·96 | ·96 |
| Harwarden, North Wales .. .. | 62·39 | ·69 |
| Dowlais, South Wales .. .. | 63·02 | 1·04 |
| Yellow London clay (dry) .. .. | 64·52 | ·50 |
| Ewell brick, Surrey .. .. .. | 91·84 | trace |
| Dinas brick, South Wales .. .. | 94·33 | " |
| Black alder, Devonshire .. .. | 75·16 | " |

From the above results it is apparent that in furnaces where clay ironstone is used, the source of the titanium is the clay in the ore and the shale attached to it. In silicious ores, such as the hematites, the titanium most probably is obtained from the Rutile, which is frequently found in quartz, and perhaps partly from the fire bricks, and shale, which is frequently used.

The minerals of titanium, viz., Rutile, and Titanic acid mixed

* These analyses were made in my laboratory by my late pupil, Mr. Betley.

with iron, are largely found in Norway, and can be brought over to this country at a very cheap rate. Rutile, which commercially speaking, is pure titanic acid, can be purchased here for 10*l*. per ton, or even less if it were taken in large quantity; and iron ores, such as shown in the analyses given, can be bought at from 20*s*. to 40*s*. per ton.

Recently a series of patents have been secured by Mr. R. Mushet, for the use and application of titanium in the manufacture of iron and steel, and for alloying titanium with iron and steel, in which very beneficial results are claimed for the action of the titanium.

Before entering upon the question as to the effects of titanium, it will be well to consider if titanium alloys with iron, and, if so, to what extent. Up to the end of 1862 the author examined many samples of pig-iron, and Mr. Mushet's steel itself specially, with the view of detecting titanium; but in no case could any distinct evidence of its presence be proved, except occasionally as a minute trace. My conclusion at that time was that titanium did not alloy with iron, and my opinion on this point was strengthened by the results of M. St. Claire Deville, of Paris, who has paid especial attention to the subject; and Dr. Percy observed also, that he could never find it. M. St. Claire Deville mentioned to me, in the course of some conversation on the subject, that he had occasionally seen red crystals of titanium in the pig itself, and it was only then that he could detect the presence of the metal. The general opinion of English chemists, who had paid attention to the subject, was that titanium did not practically alloy with iron.

At the end of last year some samples of pig-iron were submitted to me, one of which was made from red hematite mixed with 7½ % of Norwegian ore, similar to the analyses previously given. The analysis of this sample of pig gave distinct evidence of the presence of an appreciable amount of titanium; and in other samples, sent at the same time, reported to be made from red hematite alone, to my surprise titanium was also found, but not quite to such a large amount. This could not be satisfactorily accounted for until the persons sending me the pig, informed me that 10 % of Irish (Belfast) ore had been mixed with the hematite; and on examining this ore, it was found to contain some amount of titanium, as seen by the following analysis:—

BELFAST IRON ORE, dried at 280° Fahrenheit.

| | |
|---|---|
| Silica | 9·87 |
| Peroxide of iron | 27·93 |
| Protoxide of iron | 5·08 |
| Alumina | 34·57 |
| Titanic acid | 3·51 |
| Manganese | traces |
| Lime | ·91 |
| Magnesia | ·62 |
| Combined water | 19·36 |
| Phosphoric acid and copper | traces |
| | 101·85 |
| Metallic iron °/₀ | 23·5 |

The use of this ore in the furnace was attended with considerable advantage on account of the high percentage of alumina it contains, thus forming a more readily fusible double silicate with the silica contained in the hematite.

The method pursued to detect titanium was the same as that adopted and given in my paper in the journal of the Chemical Society for 1862, page 311. It however required no very special method to point out its presence, and it was readily found in the silica obtained in the portion of pig used for the determination of phosphoric acid, by simply treating the silica with hydrofluoric and sulphuric acids, evaporating to dryness and igniting. Thus 120·845 grns. of pig gave silica 4·29, which left a residue, when treated as above, of ·31. This was slightly tinged in colour by iron, and on fusing it with bisulphate of potash, dissolving the fused mass in cold water, and boiling, the characteristic precipitate of titanic acid was obtained, which gave the reactions peculiar to titanic acid in the blowpipe flame with microcosmic salt. The whole of the titanic acid cannot be separated with the silica, and a considerable amount is in solution with the iron.* However, to determine accu-

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* The following are methods that have been adopted to separate the titanic acid:—A weighed portion of the borings of the pig are treated with fuming nitric acid in a flask, a few drops of hydrochloric acid added from time to time, the whole being well boiled. The contents of the flask are then transferred into a porcelain dish, evaporated to dryness and heated strongly. On cooling, it will be found that oxide of iron readily detaches itself from the dish, and can be easily transferred into a beaker, the portions left on the dish being dissolved in hydrochloric acid, and poured on the contents of the beaker; the dish may be washed, or nearly so, with strong hydrochloric acid. The contents of the beaker are boiled for from two to three hours until complete solution of the iron is effected; and as some quantity of hydrochloric acid is required for this, my usual plan is to allow a large portion of the excess of acid to evaporate in the beaker, retaining only as much as is requisite to keep up in solution the iron. The silica is filtered off in the usual way, after diluting with water and adding a few drops of hydrochloric acid on the filter to dissolve the basic salt formed by the water. By this means the silica can be obtained very nearly white after burning off the graphite, and very little iron will be found with it except the pig contain much phosphorus, as the silica invariably contains more or less phosphate of iron from insoluble phosphide of iron, which cannot be completely dissolved out by hydrochloric acid. In the filtrate from the silica the sulphur in the pig may be determined, and subsequently the phosphoric acid, by removing first the excess of chloride of barium used to precipitate the sulphuric acid. Before determining the titanium and phosphoric acid, the residue from the silica should be fused with bisulphate of potash dissolved in water, and added to the solution of iron in which the phosphorus and titanium are to be determined. The solution is reduced with sulphite of soda, and excess of sulphurous acid is driven off by boiling. The solution is then nearly neutralised with ammonia, and acetate of ammonia or soda added; and if there is only a small quantity of phosphoric acid, there will always be sufficient peroxide of iron to precipitate it, but if not, a few drops of nitric acid must be added, so that the precipitate produced is distinctly red, and the solution is boiled and filtered as quickly as possible. This precipitate may be at once treated, or if it contains much peroxide of iron in excess of that sufficient to form phosphate of iron, it is better to redissolve it in HCl, re-reduce it with sulphite of soda, and repeat the operation above described again. The precipitate is then dissolved in hydrochloric acid, and chloride of magnesium, ammonia, chloride of ammonium, and tartaric acid added, the precipitate produced being allowed to stand two nights; ·n the ammonia-phosphate of magnesia filtered off, dried, ignited, and weighed,

rately titanic acid, oxide of iron ought to be entirely absent, as it either prevents its precipitation altogether, or materially retards it. This is in fact the great reason why titanic acid has been so frequently overlooked, and so many errors made. Some special experiments on this point will be found in my paper previously alluded to.

Titanium may, however, be found more satisfactorily and more readily, during the process usually adopted to determine the amount of graphite in pig-iron, provided a large quantity of the pig be operated on. In the analysis of the pigs alluded to, about 200 grns. of the pig were dissolved in dilute hydrochloric acid; when the pig was nearly all dissolved, and the action of the acid had ceased, more hydrochloric acid was added, and the solution well boiled so as thoroughly to extract all the iron. The solution was then thrown on dried counterpoised filters encircling each other, and the filter well washed to remove all the iron. It was then treated with dilute potash, and washed once; then re-treated with it, so as to remove entirely the silica. The potash was thoroughly washed out, and the filter treated with hydrochloric acid, thoroughly washed and dried at 250° Fahrenheit, until the weight was constant. This gave the graphite, on burning which a residue of a dirty light brown colour was left, which, on being fused with bisulphate of potash and treated as before, proved that the residue was nearly pure titanic acid, as will be seen from the results below :—

| | Grains of Pig taken. | Graphite and Titanic Acid. | Residue after Burning. | Titanic Acid obtained. |
|---|---|---|---|---|
| No. 1 Pig .. | 205·68 | 7·82 | 1·23 | 1·085 |
| „ 2 „ .. .. | 207·05 | 7·85 | ·835 | ·745 |
| „ 3 „ .. .. | 216·86 | 7·04 | ·33 | ·28 |

and the phosphoric acid calculated from the pyrophosphate of magnesia. The filtrate from the phosphoric acid is treated with sulphide of ammonium, and the sulphide of iron separated, the filtrate evaporated to dryness, ignited, and burnt in a muffle; or evaporated nearly to dryness, transferred into a Florence oil flask, and treated with fuming nitric acid until all the tartaric acid is destroyed; in either case the residue is fused with bisulphate of potash, or where nitric acid is used, this is driven off with sulphuric acid. The fusion with bisulphate of potash is dissolved in cold water, boiled for some hours, and allowed to stand a night in a warm place, when the titanic acid is filtered off and washed with dilute sulphuric acid—dried, ignited, and weighed. If the determination of phosphoric acid is not required, then the precipitate produced (either by one treatment or two) by the alkaline acetate, may be dried (without washing), burnt, and fused with bisulphate of potash, dissolved in cold water, when a little phosphate of iron, which remains insoluble, is separated; and the solution being boiled, the titanic acid is precipitated, and may be separated as before.

Neither of the above two processes are very satisfactory for the quantitative determination of titanic acid. The first is very tedious, and destroying the tartaric acid very troublesome; while in the second method, the phosphate of iron (insoluble in the bisulphate of potash) cannot be washed without its passing through the filter, and very frequently also the small amount of iron keeps up the titanic acid, as iron even in small quantities has a very great effect in preventing the precipitation of titanic acid, so that it is always advisable to add a little sulphite of soda, which reduces the oxide of iron and facilitates the precipitation of the titanic acid.

The amount of titanic acid, or rather residue, obtained from the silica after it had been volatilised with hydrofluoric and sulphuric acids, when the pig was dissolved in nitro-hydrochloric acid evaporated to dryness, and redissolved in hydrochloric acid—is given below:—

| | Grains of Pig taken. | Silica obtained. | Residue by Hydrofluoric and Sulphuric Acids. |
|---|---|---|---|
| No. 1 .. .. | 120·845 | 4·29 | ·31 |
| „ 2 .. .. | 127·93 | 8·659 | ·20 |
| „ 3 .. .. | 122·55 | 9·22 | ·265 |

This residue, chiefly titanic acid, contained, however, some iron, and was not so pure as that obtained by burning the graphite, given in the above table. The following are the tabulated results of the analyses of the three samples of pig:—

| | 1. | 2. | 3. |
|---|---|---|---|
| Carbon.. .. .. | 3·31 | 3·18 | 3·11 |
| Silicium .. .. | 1·86 | 3·28 | 3·55 |
| Iron .. .. .. | 93·47 | 92·79 | 92·04 |
| Manganese .. .. | ·50 | ·48 | 1·09 |
| Sulphur .. .. | ·071 | ·058 | ·112 |
| Phosphorus .. .. | ·076 | ·062 | ·093 |
| Titanium .. .. | 1·150 | ·71 | ·470 |
| | 100·437 | 100·560 | 100·465 |

In all these the carbon was combined; and traces of antimony, nickel, copper, and cobalt were found in all three samples.—Samples 1 and 2 were No. 3 grey iron; and sample 3 was bright iron.

The percentage of titanium given in the above analyses differs from that in the preceding table, due probably to the hydrochloric acid dissolving some of the titanium. From 15 to 16 grns. of the pig are dissolved in nitro-hydrochloric acid, and the solution evaporated to dryness, the silica separated in the usual way and volatilised with hydrofluoric and sulphuric acids, the residue fused with a little bisulphate of potash, dissolved in cold water, and added to the filtrate from the silica. The solution is precipitated with acetate of soda or ammonia, first nearly neutralising it with ammonia; after boiling well, the basic peracetate of iron is filtered off, and well washed, adding occasionally a drop or two of the alkaline acetate. The filter is then dissolved in hydrochloric acid, and peroxide of iron precipitated by ammonia, filtered, dried and ignited in the usual way. The peroxide of iron is then dissolved in hydrochloric acid, and, the small amount of silica present separated, the solution is reduced with sulphite of soda, and the iron determined with a standard solution of bichromate of potash. This gives the percentage of iron, or of pure peroxide of iron; and the difference between the peroxide of iron weighed, and that determined by standard solution, is considered to be titanic acid and phosphoric acid. The phosphoric acid having

been determined by another distinct operation, the amount present in the peroxide of iron is calculated and deducted from the above difference — the remainder being considered to be titanic acid, from which the percentage of titanium in the pig is calculated. This determination by loss is not so satisfactory as a direct determination, and is probably a little high; and the true percentage of titanium will probably lie between that given in the table and that in the analyses. Subsequently to the analyses of the above three samples of pig, a sample of iron made wholly with hematite was tested for titanium, but none was detected. Recently I have examined some samples of pig-iron made from a mixture of Cornish ores, Irish bog-ore, and hematite ore; the result shows that the pig contains some amount of titanium; the following is a partial analysis* of the Cornish ores used :—

| | | | | |
|---|---|---|---|---|
| Silicious matter .. .. .. | 23·38 | 21·70 | 27·18 | 21·03 |
| Peroxide of iron .. .. .. | 41·96 | 56·32 | 47·32 | 70·20 |
| Peroxide of manganese .. .. | 25·77 | 16·11 | 16·25 | 2·45 |
| Percentage of metallic iron .. | 29·38 | 39·43 | 33·14 | 49·14 |
| „ „ manganese .. | 16·08 | 10·25 | 10·34 | 1·55 |

These ores contained a little phosphoric acid.

The following are the results of the analyses of three samples of this pig; the titanium being determined as in the other analyses of pig given :—

| | I. | II. | III. |
|---|---|---|---|
| Graphite .. .. .. .. | 3·12 | 3·010 | 2·615 |
| Combined carbon.. .. .. | ·310 | 1·020 | ·074 |
| Silicium .. .. .. .. | 2·590 | 2·550 | 3·325 |
| Iron .. .. .. .. | 87·900 | 86·880 | 84·256 |
| Manganese .. .. .. | 5·850 | 6·370 | 8·087 |
| Nickel and cobalt.. .. .. | ·060 | ·110 | — |
| Copper with a little antimony .. | ·060 | ·045 | ·064 |
| Phosphorus .. .. .. | ·147 | ·154 | ·201 |
| Sulphur .. .. .. .. | ·026 | ·026 | ·017 |
| Titanium .. .. .. .. | ·790 | 1·150 | 1·629 |
| | 100·853 | 101·815 | 100·268 |

Samples I and II were made with a mixture of ⅓ Cornish ore; ⅓ Irish bog-ore, ⅓ hematite; and sample III, ⅓ Irish bog-ore, ⅔ Cornish ore. The Irish bog-ore contained 7 to 9 °/ₒ of manganese.

These samples of pig were Nos. 1 and 2, with here and there patches of bright iron. Nos. 1 and 2 were drilled, but were rather hard; No. 3 was too hard to drill, or could only be drilled with great difficulty. They were made specially to see to what extent, on a large scale, manganese could be made to alloy with iron; and also if a pig could not be made in this country similar to Spiegeleisen, and adapted for the purpose of carbonising the iron after blowing by the Bessemer process. The percentage of manganese in the analysis of sample III is the highest that has ever come under my notice in grey pig-iron.

* Analysis made in my laboratory by Mr. Betley.

The question now becomes—In what state does the titanium exist in the pig—is it, or is it not, alloyed with it? The pig itself has been carefully examined with the microscope to see if any red nitride crystals could be discovered, but no indications of them have been seen. The residue, after dissolving the pig in hydrochloric acid, washing out all soluble matter, and drying, has also been examined, but only distinct graphite plates could be seen, with transparent gelatinous silica, having the appearance of chalcedony; and also some of this residue, after the silica had been separated, was examined, but no indication of any other substance besides the graphite could be seen. From the above it is evident that the titanium must be either disseminated through the pig in a finely divided amorphoses condition, or it must be alloyed with it.

Samples of Mr. Mushet's steel, in the manufacture of which titaniferous ores had been used, were also examined, but in no case has any evidence of the presence of titanium been detected. Several experiments conducted on a small scale with titaniferous iron ores show that no increase in the yield of iron is obtained by the presence of titanic acid, and that when this substance is present in any quantity it is very difficult to flux, or to get a good cinder; so that it is always necessary to have a large amount of an easily fusible silicate, before satisfactory results can be obtained in the reduction of ores containing titanic acid. The following are the results of the dry assays of some titaniferous iron ore, containing by wet assay 39·08 % of iron:—

| | 1. | | 2. | |
|---|---|---|---|---|
| Iron ore .. .. | 500 | 500 | 500 | 500 |
| Clay .. .. .. | 100 | 100 | 50 | 100 |
| Lime .. .. .. | 250 | 230 | 150 | 180 |
| Anthracite .. .. | 80 | 75 | 75 | 70 |
| | 930 | 905 | 775 | 850 |

The two assays marked 1 were perfect, and a good button of iron obtained, yielding 37·76 % of iron in the ore, the cinder being of a dark blue colour; but in the assays marked 2, the cinder was almost black, semi-fused, and contained cavities with acicular crystals.

It must, however, be admitted, that when titanic acid is present in iron ores, it appears to impart a steely nature to the iron reduced from them, somewhat similar to that obtained by the use of manganese; and fluxes that have been used with advantage at Sheffield have, on analysis, been proved to contain a high percentage of titanic acid. The pig iron made with 7½ % of titaniferous iron ore, of which the analysis is given, proved also to be an iron of very great strength, and excellent quality both for castings and for the Bessemer process.

In conclusion, my opinion as to the use of titanium is, that it appears to have some beneficial effect in the manufacture of iron and steel, and to act somewhat similarly to manganese. The rationale of its action possibly is that the titanium acts as a carrier of cyonogen to the steel, from its known affinity for carbon and nitrogen. The action however of manganese is by no means well understood; the ~me may be said of the cyanides; and to determine it require the

experiments to be more carefully conducted than has been hitherto done, before we can solve the question as to the part (if any) that nitrogen plays in the manufacture of steel. The above points are at the present time engaging my attention; but my object in this paper is to prove that under certain conditions titanium is a constituent part of pig-iron, and not to enter into theoretical considerations on the composition of iron and steel.

# On the Impurities contained in Lead and their Influence on its Technical Uses.

By William Baker, Associate of the Royal School of Mines, F.C.S.

The methods employed in this country for smelting lead from its ore are now almost entirely confined to the treatment of the crushed galena in a reverberatory furnace without any previous calcination. In some places the Scotch ore-hearth still exists, when a blast of air is used in the reduction. In all cases the rich slags from the reducing furnaces are smelted either in the slag hearth or in the Castilian furnace, both of which are also worked with a blast. In the Castilian furnace poor ores are reduced along with the slags. The pig lead, as it is delivered to the manufacturers from these operations, is easily distinguished by its physical characters—and is known either as *soft* or *hard* lead. That which is smelted from an average good ore in the reverberatory furnace is always soft and fit for rolling or making into pipes. That which is smelted by the aid of a blast at a high temperature, even if the same ore is employed, is invariably hard. Of course there are different degrees of these qualities but the distinction is marked between these two classes of lead.

The characters by which pure lead is known are its softness and malleability—its appearance when melted, and its surface when poured out into a mould. Pure lead rolls without cracking at the edges; when melted and skimmed at a low temperature it is *white* and possesses a smooth mirror-like surface; and at a higher temperature the succession of colours produced by oxidation is by no means so variegated as in lead containing certain impurities. The surface of an ingot presents a confused and interlacing mass of arborescent or fern-like crystals, which impart an unevenness at the moment of solidification. A pig of such lead, when broken (which may be done by carefully heating to a little below the melting point), presents a white fracture, which is largely but irregularly columnar. These forms are due to the interference of the groupings of crystals, the lines not being themselves edges of crystals. I lay some stress on the whiteness of the surface, and of the fracture of pure lead, because many common qualities of lead present also a white appearance, which is however due to the presence of certain impurities and may

be as easily distinguished as the whiteness of silver can be from that of pewter.

Such being the characteristics of pure lead, it is natural to enquire what are the impurities which render it hard, and what elements may exist in it without impairing the qualities which render it suitable for its various technical uses. The substances which commonly impart hardness to lead are sulphur, antimony, and arsenic. Copper, if alone, does not much affect the softness of lead; nor is iron, in the absence of sulphur, found in sufficient quantity to produce hardness. Ordinary soft lead generally contains from ·008 to ·010 % of iron; but both iron and copper may be introduced to a considerable amount in the form of sulphides, in which case they, as well as the sulphur, impart hardness to the metal. At a high temperature several metallic elements in combination with sulphur will melt, become diffused in the lead, and render it hard. Phosphorus or phosphide of lead will not exist in the metal; for when phosphate of lead is reduced in a close vessel, phosphorus may be distilled off and the lead obtained quite pure and soft. At a low temperature only a trace of sulphur or sulphide of lead will remain diffused in the lead. But if the temperature is increased, so much sulphide may be melted and diffused in lead as to render it decidedly hard. This explains why pure galena smelted by a blast will give a hard lead. On remelting at a low temperature the bulk of the sulphide is removed, and what remains may be shown to be unequally diffused in the metal; for, if such a piece of lead be corroded, as in the process of making white lead, irregular particles of a dark colour may be seen in the mass of white carbonate.

In the process of oxidation of lead for making red lead, it has been the custom to add a pig of hard or slag lead to the charge for the purpose of promoting the oxidation. I have melted together pure galena and lead in the proportion of 2 % of the sulphide, and produced a hard lead which answered the purpose quite as well as the slag lead usually employed.

Antimony, tin, and zinc impart a whiteness to lead, each peculiar to itself. Zinc is however seldom found in lead, and tin exists in but small quantities: antimony is the chief element which, with sulphur or alone, gives the characteristic hardness and whiteness to slag lead. At the high temperature of the blast-furnace, therefore, we may have sulphides of antimony, copper, iron, and arsenic diffused in the lead as it is reduced and runs down into the kettle. Such is the hard lead which must be specially treated before it can be used in the arts.

Refining processes for impure lead are essentially oxidising processes. When the amount of antimony is not more than 1 to 2 %, as in Derbyshire slag lead, the pigs are placed on the bed of the ordinary reducing furnace, and melted down with free access of air. This is really a liquation as well as an oxidising process; the separation of the lead from its impurities being effected by taking advantage of the difference between the melting points of lead and the mixed sulphides—the latter being left on the bed of the furnace, whilst the purified lead in an oxidising atmosphere runs into the pot. I have introduced an oxidising agent for effecting the

softening of slag lead as it is tapped from the blast-furnace. If nitrate of soda be stirred into the lead whilst kept at a heat just below redness, the sulphides are immediately attacked, and, instead of the white smooth surface it first possessed, a play of irridescent colours and a wrinkled surface disclose the characteristic appearances of ordinary soft lead. When a large quantity of antimony is present, as in most Spanish leads, the metal is treated in an improving furnace, where it is calcined or subjected to an oxidising flame for a length of time varying with the hardness of the lead. The rich antimonial slags are resmelted, and ultimately a product is obtained from them which may contain 20 to 30 % of antimony. A method of separating lead and antimony is yet a desideratum in metallurgy.—The softened lead is treated by Pattinson's process for the concentration of the silver.

Softened lead may still contain traces of antimony, sulphur, tin, and iron, and a yet more notable quantity of copper. If free from tin and antimony, it gives a fine display of colours on melting; and on increasing the temperature the film of litharge which is formed cracks in all directions, showing when the lead is agitated a wrinkled surface, characteristic of soft lead. Softened lead breaks with a *fibrous*, not with a granular, fracture, and the fractured surface is usually coloured with purple and blue tints.

We have now to deal with the impurities left in the softened lead. It is in the operation of desilverising lead by Pattinson's process that a further elimination of foreign elements takes place. Upon separating the crystals from the fluid alloy, I find that when we have to deal with a properly softened metal the trace of iron remains unaffected in quantity. Antimony appears to become concentrated along with the silver, but to what extent, remains to be proved by a series of analyses. In 1856, I showed that copper also is found with the silver; but if present in a proportion above 10 ozs. per ton, eight or ten operations will be necessary to reduce its amount to a trace; and when it is present to the amount of 20 ozs. per ton (= ·06 %), six crystallising operations failed to diminish its quantity in the refined lead. Reich, in a communication published in the *Jahrbuch für den Berg- und Hüttenmann*, 1860, has shown that most of the copper goes with the dross, which is removed from the lead previous to the crystallising operation. But this is only true when the copper is in notable quantities as sulphide. In the experiments which he adduces, the copper seems never to be reduced beyond ·10 %. At the point Reich leaves off I begin—not considering that lead to be soft which contains more than ·10 %. To prove if it be possible to reduce the amount of copper in this manner, lead containing ·05 % of copper was melted with a little pure galena, and the pasty skimmings removed. The lead still contained ·05 % and the dross contained ·048 %; so that therefore no separation had been effected.

It is however highly important for certain technical uses that lead should be practically free from copper, although it may contain 20 ozs. per ton without detriment for rolling into sheets and making pipes—2 ozs. per ton or even less render it objectionable for making into white lead or glass makers' red lead. This fact I have

established by numerous experiments and analyses, among which are the following.

When lead containing a certain amount of copper is placed in dilute nitric acid, the lead oxidises before the copper, and a reddish moss covers the surface of the lead as it dissolves. In a similar manner, by the slow oxidation of lead in the process of making white lead, the particles of copper, or suboxide, are carried and locked up in the corrosion, imparting in some cases a delicate pink tint to the carbonate of lead. In a bed of corroded lead, all cast out of the same pan, a portion will exhibit a pink colour, whilst another is white. The appearance of the pink colour therefore is influenced by the position of the lead on the bed. Closer observation will discover that where the current of vapours arising from the fermenting tan is copious, the pink colour disappears. Where the corrosions are swelled and flowery—in a word where the air has access more freely—there is no pink colour. But in these cases there is then often visible the blue, or greenish-blue, tints of carbonate of copper. Synthetical experiments have also established this fact. Pure lead corroded in various parts of different beds invariably gave pure white corrosions. Upon adding a small quantity of copper, and submitting it to the corroding action, pink passing into blue was distinctly visible. It is worthy of notice that the pink colour is generally more striking, close to the metallic lead. The blue colour appears on the outside, or where lines of weakness have been formed by alteration of temperature, which cause the corrosion sometimes to separate in layers, thus allowing the air to penetrate.

A portion of pink corrosion suspended in a flask containing a little acetic acid gradually loses its colour, which passes into faint blue, and sometimes disappears, leaving the corrosion disintegrated and more swelled, but white. It is remarkable that the purest tint of pink is obtained with very small quantities of copper. Thus 2 ozs. per ton gives a more decided colour than 10 or 12 ozs. per ton. The pink colour may be masked by the presence of sulphur or antimony.

A manufacturing test of the truth of these statements has been made. Common slag lead softened, refined, and having the copper eliminated by a special process, produced a lead which cannot be distinguished from the most pure, and which gave pure white corrosions. Before the removal of the copper, the lead gave decided pink corrosions.

The red lead which is used for glass making should also be practically free from copper. An almost inconceivably small amount imparts a blue tint to glass. For a long time the Snailbeach lead has been reputed for glass making, and it was only after making arrangements for eliminating the copper in the manufacturing processes that lead which contained at the commencement from 5 to 8 ozs. per ton could be used with equally good results. Good red lead for this purpose should not contain more than 1 oz. per ton.

# On the Manufacture of Pig-Iron in England.

BY MM. GRUNER AND LAN.

(Abstracted from the *Annales des Mines*, 5th series, vol. xx, p. 109.)

(*Concluded from page* 149.)

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3. *Management of Furnaces; State of Working*—(*continued*). —Raw coal is used in a large number of the Welsh furnaces, in Staffordshire, and in Wales. In respect of consumption this is advisable, when the coals are long-flamed, dry, and hard, and their small cannot be converted into coke (Scotland, Staffordshire). In these cases the cooling caused by the disengagement of the gases is met by a very hot and very dense blast. The authors of the *Voyages Métallurgiques* pointed out in this case the advantages of raw coal; as we ourselves have done in a special description of the Glasgow works. But it is doubtful if this course is a wise one, in those parts of Wales where the slack is sufficiently fat to be made into coke; it is certainly a questionable policy, since, notwithstanding the fusibility of the Coal-measure ores, the consumption of fuel at these works is quite as large as in the French blast-furnaces.

In another point of view, however, the employment of raw coal is tacitly condemned by the English themselves. As soon as it is required to produce a first quality pig-metal—either in Wales, in Staffordshire, or in Yorkshire—the coal is always submitted to a previous carbonisation, which drives off at least half the sulphur, and this notwithstanding that their ores almost always contain a greater or less proportion of manganese, which acts as a corrective to the sulphur, but which is wanting in the French ores. One of the accessory advantages resulting from the use of raw coal is the larger proportion of gases given off at the throat—an advantage, however, which the English make little effort to profit by, since in the greater number of Scotch and Staffordshire furnaces, they allow these gases to go to waste.

The heating of the blast, as well as the condition of the fuel, also influences the quality of the iron produced. We know that the higher the temperature is raised the more abundant silicium becomes in the pig-metal; so that the English smelters still continue the use of cold air for the making of iron of superior quality, notwithstanding a difference of consumption amounting to between 20 and 25%. It has been maintained that the injurious effects of hot air may be completely counteracted by increasing the proportion of limestone, and enlarging the zone of fusion. This is true to a certain extent, but the experience of the English smelters proves beyond all doubt, that the remedy proposed is not sufficient, at least when easily reducible ores are treated. By increasing the burden of limestone we may indeed counteract the reduction of the silica; but by this very means we facilitate the reduction of the alumina, magnesia, and other bases.

Aluminium is indeed more abundant in pig-iron than is generally supposed, and the slight tenacity of the Scotch pig-metal is probably

partly due to the presence of this element. It has rarely been ascertained quantitatively, and indeed by the ordinary methods of analysis the alumina necessarily remains mixed with the iron and the silica. Thus Karsten states that he has found but little aluminium in pig-iron; but Truran, following Thompson, gives various cases of English pig-iron containing from ½ to 1% of aluminium—and we know that certain Swedish pig-iron contains as much as 1½% of calcium and magnesium, and ¾% of aluminium.* It is therefore necessary to look to the reduction of the earthy bases as well as that of the silica, and in this view it is evident that the English smelters are right in the preference they give to cold air over hot air, when their object is to obtain tenacious rather than soft pig-metal—or in other words very superior iron.

The temperature of the hot air is that of the melting point of lead in the works of Wales, Staffordshire, and Cleveland; and from 350° C. (660° Fahr.) to 400° C. (750° Fahr.) in Scotland. The use of hot air and of raw coal; the employment of the furnace gases; and certain modifications in the lines of the blast furnaces;—such are, on the whole, the means adopted to reduce the consumption of the English blast-furnaces. It only remains for us to refer in a few words to the use of forge-cinders as an iron ore in Wales; and the substitution of quicklime for limestone as a flux.

The employment of cinders, even more than that of hot air and raw coal, is rejected by the English iron-masters, when the object is to make superior products. Not only does their use render the pig-metal, phosphorised and siliciuretted, but it also prevents a hot working, by which alone good iron can be made from indifferent ores. The reduction of the silicates is always incomplete; and, in proportion as the burden of the forge-cinders is increased, we see that the slags become more and more black; and take up 10, 15, and even 20 % of oxide of iron. Indeed, Mr. Truran states that in Wales, in working for white metal, the slags contain on an average 11 % of metallic iron, which corresponds to 20 % of the percentage of the ores; which is more than a half of the iron derived from the cinders. Thus, according to his statement, the average charge of the Dowlais furnaces, per ton of pig-metal, is as follows:—

| | Tons. | Cwts. | | | Tons. | Cwts. | Qrs. | |
|---|---|---|---|---|---|---|---|---|
| Calcined Coal-measure Ores | 1 | 8 | of 40% | ore containing | 0 | 11 | 1½ | of iron |
| Red Hematite .. .. | 0 | 10 | „ 50 | „ „ | 0 | 5 | 0 | „ |
| Forge-cinders .. .. | 0 | 10 | „ 60 | „ „ | 0 | 6 | 0 | „ |
| Total charge .. .. | 2 | 8 | | | 1 | 2 | 1½ | „ |
| Now a ton of pig-metal contains .. .. .. .. | | | | | 0 | 19 | 0 | „ |
| Therefore there remains in the slags .. .. .. | | | | | 0 | 3 | 1½ | „ |

that is to say, upwards of 50 % of the 6 cwts. of iron furnished by the cinders. And still this 3 cwts. 1½ qrs. of iron scarcely represents 9 % of the total weight of the slags, which in this case is 1 ton 16 cwts. per ton of pig-metal produced.

It is, besides, easy to see that the iron thus lost increases nearly

* Durocher, *Ann. des Mines*, t. ix de la 6e Série, p. 475.

in proportion with the proportion of cinders which the bed of fusion contains. We ascertained at Dowlais the composition of the beds of fusion of the 16 blast-furnaces which were in work at the period of our visit. From this, on the data given by Truran, we arrive at the following results:—

| Composition of Charge per Ton of Pig. | Tons. Cwts. | Percentage of Ores. | Iron contained in Charge. Tons. Cwts. | Iron that passes into the Slags. Tons. Cwts. | Observations. |
|---|---|---|---|---|---|
| Calcined Coal-measure Ores .. .. | 1 0 | 40 | 0 8 | — | Mottled pig. The slag contains about 4 °/o of metallic iron. |
| Red Hematite .. .. | 0 19 | 50 | 0 9½ | — | |
| Cinders .. .. .. | 0 5 | 60 | 0 3 | — | |
| | 2 4 | .. | 1 0½ | 0 1½ | |
| Coal-measure Ores .. | 1 1 | 40 | 0 8½ | — | Lamellar white pig. |
| Red Hematite .. .. | 0 18 | 50 | 0 9 | — | |
| Cinders .. .. .. | 0 6 | 60 | 0 3½ | — | |
| | 2 5 | .. | 1 1 | 0 2 | |
| Coal-measure Ores .. | 1 0 | 40 | 0 8 | — | Lamellar white pig. |
| Red Hematite .. .. | 0 17 | 50 | 0 8½ | — | |
| Cinders .. .. .. | 0 8 | 60 | 0 5 | — | |
| | 2 5 | .. | 1 1½ | 0 2¼ | |
| Coal-measure Ores .. | 0 14 | 40 | 0 5½ | — | White pig, more or less fibrous. |
| Red Hematite .. .. | 1 1 | 50 | 0 10½ | — | |
| Cinders .. .. .. | 0 9 | 60 | 0 5½ | — | |
| | 2 4 | .. | 1 1½ | 0 2½ | |
| Coal-measure Ores .. | 1 5 | 40 | 0 10 | — | Granular white pig. The slags contain 11 °/o of metallic iron. |
| Red Hematite .. .. | 0 7 | 50 | 0 3½ | — | |
| Cinders .. .. .. | 0 16 | 60 | 0 9½ | — | |
| | 2 8 | .. | 1 3 | 0 4 | |
| Coal-measure Ores .. | 1 15 | 40 | 0 14 | — | White pig, granular or cavernous. The slag contains 21 °/o of metallic iron. |
| Cinders .. .. .. | 1 1 | 60 | 0 12½ | — | |
| | 2 16 | .. | 1 6½ | 0 7½ | |

The percentage of the ores is doubtlessly not rigorously invariable, consequently the results in this table are only approximate; but, taking them even as such, they still clearly show that the loss in the blast-furnace is about half the iron contained in the cinders. As a means of comparison, we give the following statement of the mixture used at the same works for making grey foundry pig-metal:—

| | Tons. | Cwt. | Qrs. | | Cwts. | Qrs. | |
|---|---|---|---|---|---|---|---|
| Calcined Coal-measure Ores .. | 2 | 7 | 0 | of 40°/₀ ore containing | 18 | 3¼ | of iron |
| Red Hematite .. .. .. | 0 | 1 | 2 | „ 50 „ „ | 0 | 3 | „ |
| | 2 | 8 | 2 | | 19 | 2¼ | „ |
| Which only leaves in the slags about .. .. .. .. | | | | | 0 | 2 | „ |

or about 1¼°/₀ of their weight.

Now if we deduct from the forge-cinders half the iron they contain, and if we bear in mind besides that they injure the quality of the pig-metal and reduce its selling price, we may fairly ask if their continued use is judicious. Besides, of all iron ores those of the Coal-measures are least fit to be mixed with the cinders, in consequence of their reducibility, and fusibility: a refractory argillaceous ore would more readily bear a mixture of cinders. In any case, if in France (taking into consideration the high price of fuel and the low price of ores), there might be an advantage in working for white forge pig-metal (even without mixing forge-cinders), and thus sacrificing a portion of the iron in the ores themselves—this is not the case in England, where the ores are always dear. So that, independent of any other consideration, the high price of the ores should lead to the adoption of a hot rather than a cold working, when there are no cinders used.

The red hematites of Cumberland could from their purity readily afford superior quality white pig-metal, granular or fibrous; but the loss of iron would be greater than the profit resulting from the reduced consumption of coal. We see therefore, that in every point of view, it is the interest of the English smelters to produce a *grey* iron; and that even in Wales a cold working has so many inconveniences that it will probably be some day advisable to abandon it—if not for grey iron proper, at least for a lamellar white pig-metal.

In certain works of Wales and Staffordshire (Sirhowy, Russell works, &c.), quicklime has been substituted for raw limestone as a flux. It is well known that trials of a similar kind have been made in various places—specially, at Königshütte in Silesia, and at Ougrée near Liège. The calcining of the limestone in the furnace itself retards the reduction of the ores in the upper part of the body—either by the cooling caused by the disengagement of the gaseous element, or by the comparative abundance of carbonic acid, which modifies the reducing action of the oxide of carbon. It would seem, therefore, that the advantage resulting from the employment of quicklime would simply be a reduction in the weight of fuel, and in a more rapid working of the furnace. According to the *Revue de Liège*, this is indeed the result which followed at Ougrée, where the economy in the coke was 9·6 % and the increase of reduction 25 %. But at Königshütte the economical advantages were insignificant;—at most 6*d*. per ton of pig, and at times even altogether null, if not negative if we take into account the coke cinders (derived from the puddling furnaces), which are used in calcining the limestone. In England (at Sirhowy as well as at the Russell works) we were informed that the quicklime had certain advantages over the raw limestone. Still we found it impossible to get at its amount, and we think it cannot be great, otherwise the Ebbwvale company to whom

| NAME OF WORKS. | Capacity of Body. | Production per 24 hours. | Number of Twyers or Nozzles. | Diameter of Nozzles. | Pressure of the Blast. | Temperature of Blast. | Volume of blast per ton of pig iron, calculated from the carbon consumed. | Volume of blast per minute, from carbon consumed. | Volume of blast per minute per cubic foot of capacity. | Consumption per ton of pig-metal. Calcined Ore. | Consumption per ton of pig-metal. Limestone. | Consumption per ton of pig-metal. Coal. At the blast-furnace. | Consumption per ton of pig-metal. Coal. For hot-air, boilers, and calcining. | Fixed carbon consumed at the blast-furnace. | Ore and Limestone melted per ton of coal consumed at blast-furnace. | Nature of Pig-metal, and Observations. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cub.yds. | Tons. | | In. | lbs. | Fahr. | Cubic ft. | Cubic ft. | Cubic ft | Cwts. | Cwts. | Cwts. | Cwts. | Cwts. | Cwts. | |
| Ordinary Scotch furnaces (fig. 1) ... ... | 195—210 | 20—21 | 4—6 | 3—3½ | 2⅝—3⅜ | 750 | 179,465 | 2,600 | ·5 | 35 | 8 | 42 | 10 | 23 | 20 | Black. |
| Old Scotch furnaces (1833)... | 110—120 | 9 | 2—3 | 3 | 2⅛—2¼ | 600 | 144,270–204,660 | 1,000–1,250 | ·4 | 21½ | 6¾ | 40—48 | 19 | 21½–26 | 20–24½ | Ditto |
| Blast-furnaces of the high Scotch type (fig. 2) | 260 | 26 | 8—9 | 3 | 2¾ | 700 | 196,790 | 3,500 | ·5 | 39 | 8 | 46 | 10 | 25 | 20 | Ditto |
| Furnaces at Bilston, No. 3 (fig. 3) ... ... | 230 | 24 | 5—7 | ? | 2½—3 | 570—625 | 236,150 | 3,900 | ·63 | 43 | 10 | 60 | 7 | 30 | 17¾ | Grey forge |
| Modern Staffordshire furnaces (fig. 4) ... | 155—170 | 16—20 | 5—7 | 3 | 2½—3 | 670—625 | 220,410–236,150 | 2,450–3,300 | ·58–·71 | 42—45 | 9—12 | 55—60 | 15—20 | 28—30 | 18½–19 | Grey forge and foundry (1) |
| Old Staffordshire furnaces (1840-1850) ... | 90—97 | 10 | 3 | 2—2¾ | 2—2½ | 570—55 | 236,150–283,380 | 1,600–1,900 | ·65–·73 | 43 | 9—10 | 60—70 | 14—20 | 30—36 | 15—17 | Ditto (2) |
| New anthracite furnaces at Yniscedwin and Ystalyfera | 105—110 | 10—12 | 6—7 | 1¼—1½ | 3⅛—3⅜ | 650—750 | 236,150 | 1,600–1,950 | ·57–·66 | 48 | 16 | 35 | 20 | 30 | 36½ | Ditto (3) |
| Furnaces at Blaenavon (fig. 6) ... ... | 145 | 14—15 | 3 | ? | 2¾ | 55 | 275,520 | 2,700 | ·71 | 54 | 19½ | 61 | 14 | 35 | 24 | Ditto (4) |
| Blast-furnaces of the Tees-side, Middlesboro' (fig. 7) | 250—260 | 30 | 30 | 4 | 2½—2⅝ | 570—625 | 198,380 | 4,000 | ·58–·6 | 50 | 13—14 | 52 | 15 | 25 | 24½ | Grey forge (5) |
| Ordinary Middlesboro' furnaces (1850–5), fig. 9 | 175—180 | 20—25 | 3—5 | 3½—4 | 2⅛—2⅝ | 570—625 | 220,410 | 3,000–3,500 | ·63–·71 | 48 | 14 | 60 | 15 | 28 | 20½ | Grey foundry and forge (6) |
| Large furnace at Dowlais (fig. 10) ... ... | 300—305 | 45—50 | 7 | 3—3⅜ | 2¾—3 | 600—625 | 188,920 | 6,400 | ·77 | 48 | 17 | 40 | 7 | 24 | 32½ | White lamellar or granular (7) |
| Ebbwvale furnaces (fig. 11) | 210—220 | 25—30 | 6 | 3—3¼ | 2½—3 | 570—625 | 204,670 | 3,500–4,000 | ·63–·7 | 52½ | 20 | 48 | 5 | 26 | 30 | White lamellar (8) |
| Ordinary furnaces at Dowlais | 180—195 | 25 | 5—7 | 3 | 2½—3 | 570—625 | 175,230 | 3,000 | ·57–·61 | 48 | 17 | 38 | 7 | 22½ | 34 | White granular (9) |
| Blast-furnaces at Victoria (fig. 14) ... ... | 150—155 | 24 | 5—6 | 3—3¼ | 2½—3 | 570—625 | 181,550 | 3,000 | ·73 | 52½ | 10 | 44 | 5 | 23 | 28½ | Ditto (10) |
| Blast-furnaces at Tredegar | 155—160 | 20—22 | The conditions of the blast nearly same as at Victoria. | | | | 201,530 | 2,800 | ·66 | 55 | 12½ quicklime | 47 | 5 | 25½ | 28½ | Ditto (11) |
| Blast-furnaces at Sirhowy ... | 136 | 20—21 | ... | 2½—3½ | 3⅛ | 625 | 165,190 | 2,400 | ·64 | 53 | 10 | 40 | 5 | 21 | 31½ | White (12) |

the Sirhowy works belong, would certainly have introduced the use of quicklime into their works at Victoria, Ebbwvale, Abersychan, and Pontypool. It would seem indeed from a note in *Karsten's Archives*, that in 1851, one of the Ebbwvale furnaces worked with quicklime, which is no longer the case at present. In referring to the general table of production, which we have already given (see *ante*, p. 13), and the one on preceding page, we see that the production of Sirhowy is the same as that of Victoria—that is 1 ton per 6½ cubic yards of capacity—and that the difference of the consumption of coal, per ton of iron made, is scarcely 4 cwts. out of 2 tons 4 cwts.

4. *Production and Consumption of the English Blast-furnaces.*—We shall conclude this notice by referring to the general table of the production and consumption of blast-furnaces in different districts, in preceding page, which is supplementary to the one already given (*ante* p. 13). By comparing the two, the reader is in a position to check the conclusions we have arrived at.

NOTE.—The figures referred to will be found in Plate III, vol. i, *Mining and Smelting Magazine.*

(1). The greater consumption in coal and limestone applies to the foundry-pig.

(2). The lower figures refer to cold air.

(3). The blast-furnaces at Ystalyfera have as many as *ten* twyers, but they are rarely all in use.

(4). The working is with coke and cold air. The consumption of coke is 1 ton 19 cwts.

(5). The consumption of coke is 1 ton 8 cwts. for forge-pig, and 1 ton 14 cwts. for foundry-pig.

(6). The consumption of coke is 1 ton 12 cwts. for the mixture of foundry- and forge-pig.

(7). Working almost exclusively with raw coal.

(8). Working with one-third coal, and two-thirds coke.

(9). Working principally with raw coal. Some furnaces only consume from 1 ton 10 cwts. to 1 ton 15 cwts. of coal.

(10). Charging principally cinders and silicious ores. For that reason little limestone.

(11). Working with a mixture of coal and coke.

(12). Charging half coke and half coal.

## Description of Monte Catini Mine, Tuscany.

BY NELSON BOYD, MINING ENGINEER.

THE Monte Catini copper mine, the most successful in Tuscany, and probably among one of the most profitable in Europe, is situated within a mile of the village of the same name, in the province of Volterra, eight miles north-east from the town of Volterra, and ten miles from the sea-coast, on the left of the valley of the Cecina.

This mine is not only interesting from its productiveness, but also from the peculiar geological formation in which it lies. The Tertiary formation of Tuscany has, at this point, as at various others, been broken through by large masses of serpentine—forming, with the accompanying rocks, several considerable ranges of hills. The most important of the rocks found in conjunction with this serpentine is that known as Gabbro Rosso, a rock

the origin of which appears to be still the subject of discussion among geologists—some classing it with the serpentine as eruptive, and others holding it to be a locally altered limestone. It is found in large masses, forming many of the highest hills of Tuscany—as for instance, Monte Massi, close to Monte Catini, the altitude of which is nearly 2,000 feet above the level of the sea. At times it presents the appearance of a decomposed stratified rock, much broken up and contorted in the vicinity of the serpentine; and again considerable masses are found having much the appearance of volcanic origin.

The ores of the copper deposits found in connection with the serpentine are rich sulphides, with occasional bunches of native copper, contained in a matrix of decomposed serpentine and argillaceous matter. These deposits partake more of the nature of irregular masses than regular veins, which causes much uncertainty in working them; they are generally found between the serpentine and Gabbro Rosso, forming the division between the two rocks. Although ores have been found in the serpentine, and also in the Gabbro Rosso, it is only at the junction of these rocks that masses of any great value have been discovered.

The existence of copper in this district appears to have been known in remote antiquity. From old workings discovered, it is proved that the Etruscans were aware of the value of these hills, and worked them for copper. We find from records that Monte Catini was also worked in the middle ages; but that the works were stopped by the terrible plague which raged in 1300, and which changed the fertile and populous Marrema into a wilderness; from which condition it has only been recently attempted to be rescued by drainage and cultivation.

In the year 1820, some unsuccessful trials were made on the site of the present mine; and again, in 1830, a shaft was sunk—the lode discovered—and several levels (among them a deep adit) driven, but only an insignificant quantity of ore raised. It was not till the year 1837, shortly after the mine came into the hands of the present proprietors, Messrs. Hall & Sloane, that the workings showed any importance. In that year a large mass of ore was discovered, from which sufficient was raised to pay all working expenses for a year—which appeared to establish beyond all doubt the success of the undertaking, a view fully realised by subsequent events.

At present the works consist of one main shaft—Pozzo Alfredo—sunk on the foot-wall of the vein to a depth of 200 metres (260 yards). From this the mine is worked by six levels driven at intervals of 22 yards on the vein. At the depth of 180 yards, or 4 yards below the fifth level, there is a deep adit which unwaters the workings to that depth.

The vein consists of a conglomerate of decomposed serpentine and argillaceous matters, varying in width from a few inches to several yards, and in one instance being reduced to a leader of less than one inch. Its bearing is east and west, and its underlie, from the surface to the depth of 110 yards, is 45° north; below which depth it reverses its inclination, and underlies south—still preserving however the same inclination of 45°.

The ore is found in isolated nodules, irregularly dispersed through the vein—generally lying on one of the walls, and oftener on the foot than the hanging wall—but also occurring in bunches or masses, which are at times so extensive as to resemble regular beds. At the time of my visit, a deposit was being worked measuring more than 2 feet in thickness, extending over an area of 50 yards by 30 yards. These deposits are the valuable portions of the mine, and the principal operations consist in driving to discover them.

The ores are sulphides of copper, containing from 20 up to 60 °/₀ of metal; and at times fine specimens of native copper are found in the Gabbro Rosso. The total quantity raised at the Pozzo Alfredo is about 2,000 tons a-year, yielding on an average 32½ °/₀ of copper. About one-half

of this quantity is exported in barrels to Liverpool; and the remainder is conveyed to the smelting works of Prato, belonging to the same proprietors, where very superior copper is manufactured. The plant and establishment of the mine are of a superior order. An engine, of 50 H.P., raises the ore from the Pozzo Alfredo; and all mechanical appliances are in accordance with the best modern principles.

The ore brought to surface is first broken and picked by boys; and of this more than one-fourth requires no further preparation, but is directly sent away: the remainder is crushed and dressed. The number of men employed is about 250, who prove themselves to be good and steady miners; many of them having been on the ground since the opening of the mine. But although the number of hands employed is thus limited, and the quantity of ore raised not very great, the profits realised are very considerable, owing to the very high percentage of copper contained in the ore—the cheapness of labour—and the absence of the necessity of mechanical appliances for raising water.

I cannot conclude this short notice without recording my thanks for the facilities the proprietors placed at my disposal to enable me to examine the mine; and also for the kindness shown me by Mr. Schneider, the manager, to whom I am indebted for the above details.

## British Association for the Advancement of Science.

THE thirty-third meeting of the British Association commenced at Newcastle on August 26th, under the presidency of Sir William Armstrong, C.B., F.R.S. The proceedings at this meeting are more particularly interesting to our readers from the mining importance of the district in which it was held, and from the valuable papers relating to geology and mining read before it.

Among the most interesting excursions undertaken by the members of the association were:—to Mr. Beaumont's lead mines at Allenheads, where, at Allen Smelt Mill, the late Mr. Pattinson's process for desilverising lead was explained; to the Cleveland iron district, where they were shown the Clarence ironworks and those belonging to Messrs. Bolckow and Vaughan; and to the Marsden Rocks, where the main features of the geology of the coast were pointed out.

### THE PRESIDENT'S ADDRESS.

After glancing at the progress and history of railways, Sir William Armstrong went on to observe that the coal-fields of the district would doubtless receive much attention from the association at that meeting. "To persons who contend that all geological phenomena may be attributed to causes identical in nature and degree with those now in operation, the formation of coal must present a difficulty. The rankness of vegetation which must have existed in the carboniferous era, and the uniformity of climate which appears to have prevailed almost from the poles to the equator, would seem to imply a higher temperature of the earth's crust, and an atmosphere more laden with humidity and carbonic acid than exist in our day. But whatever may have been the geological conditions affecting the origin of coal, we may regard the deposits of that mineral as vast magazines of power stored up at periods immeasurably distant for our use.

"The principle of conservation of force, and the relationship now established between heat and motion, enable us to trace back the effects which we now derive from coal to equivalent agencies exercised at the

periods of its formation. The philosophical mind of George Stephenson rightly saw that coal was the embodiment of power originally derived from the sun. That small pencil of solar radiation which is arrested by our planet, and which constitutes less than the two-thousand-millionth part of the total energy sent forth from the sun, must be regarded as the power which enabled the plants of the carboniferous period to wrest the carbon they required from the oxygen with which it was combined, and eventually to deposit it as the solid material of coal. In our day, the re-union of that carbon with oxygen restores the energy expended in the former process, and thus we are enabled to utilise the power originally derived from the luminous centre of our planetary system.

"But the agency of the sun in originating coal does not stop at this point. In every period of geological history, the waters of the ocean have been lifted by the action of the sun and precipitated in rain upon the earth. This has given rise to all those sedimentary actions by which mineral substances have been collected at particular localities, and there deposited in a stratified form, with a protecting cover to preserve them for future use. The phase of the earth's existence suitable for the extensive formation of coal appears to have passed away for ever; but the quantity of that invaluable mineral which has been stored up throughout the globe for our benefit is sufficient (if used discreetly) to serve the purposes of the human race for many thousands of years. In fact, the entire quantity of coal may be considered as practically inexhaustible. Turning, however, to our own particular country, and contemplating the rate at which we are expending those seams of coal which yield the best quality of fuel, and can be worked at the least expense. we shall find much cause for anxiety. The greatness of England much depends upon the superiority of her coal in cheapness and quality over that of other nations; but we have already drawn from our choicest mines a far larger quantity of coal than has been raised in all other parts of the world put together, and the time is not remote when we shall have to encounter the disadvantages of increased cost of working and diminished value of produce.

"Estimates have been made at various periods of the time which would be required to produce complete exhaustion of all the accessible coal in the British islands. These estimates are extremely discordant; but the discrepancies arise, not from any important disagreement as to the available quantity of coal, but from the enormous difference in the rate of consumption at the various dates when the estimates were made, and also from the different views which have been entertained as to the probable increase of consumption in future years. The quantity of coal yearly worked from British mines has been almost trebled during the last twenty years, and has probably increased tenfold since the commencement of the present century; but as this increase has taken place pending the introduction of steam navigation and railway transit, and under exceptional conditions of manufacturing development, it would be too much to assume that it will continue to advance with equal rapidity. The Government statistics of the Mining Records Office show that at the end of 1861 the quantity of coal raised in the United Kingdom had reached the enormous total of eighty-six millions of tons, and that the annual average increase of the eight preceding years amounted to two millions and three quarters of tons. Let us inquire what will be the duration of our coal-fields if this more moderate rate of increase be maintained.

"By combining the known thickness of the various workable seams of coal, and computing the area of the surface under which they lie, it is easy to arrive at an estimate of the total quantity comprised in our coal-bearing strata. Assuming four thousand feet as the greatest depth at which it will ever be possible to carry on mining operations, and rejecting all seams of less than two feet in thickness, the entire quantity of available coal existing

in these islands has been calculated to amount to about eighty thousand millions of tons, which, at the present rate of consumption, would be exhausted in nine hundred and thirty years; but, with a continued yearly increase of two millions and three quarters of tons, would only last two hundred and twelve years. It is clear that, long before complete exhaustion takes place, England will have ceased to be a coal-producing country on an extensive scale. Other nations, and especially the United States of America, which possess coal-fields thirty-seven times more extensive than ours, will then be working more accessible beds at a smaller cost, and will be able to displace the English coal from every market. The question is, not how long our coal will endure before absolute exhaustion is effected, but how long will those particular coal seams last which yield coal of a quality and at a price to enable this country to maintain her present supremacy in manufacturing industry. So far as this particular district is concerned, it is generally admitted that two hundred years will be sufficient to exhaust the principal seams even at the present rate of working. If the production should continue to increase as it is now doing, the duration of those seams will not reach half that period. Were we reaping the full advantage of all the coal we burnt, no objection could be made to the largeness of the quantity, but we are using it wastefully and extravagantly in all its applications. It is probable that fully one-fourth of the entire quantity of coal raised from our mines is used in the production of heat for motive power; but, much as we are in the habit of admiring the powers of the steam engine, our present knowledge of the mechanical energy of heat shows that we realise in that engine only a small part of the thermic effect of the fuel. That a pound of coal should, in our best engines, produce an effect equal to raising a weight of a million pounds a foot high, is a result which bears the character of the marvellous, and seems to defy all further improvement. Yet the investigations of recent years have demonstrated the fact that the mechanical energy resident in a pound of coal, and liberated by its combustion, is capable of raising to the same height ten times that weight.

"It is a common observation that before coal is exhausted, some other motive agent will be discovered to take its place, and electricity is generally cited as the coming power. But in contemplating the application of electricity as a motive power, we must bear in mind that we shall still require to effect chemical combinations, and in so doing to consume materials. But where are we to find materials so economical for this purpose as the coal we derive from the earth, and the oxygen we obtain from the air? The latter costs absolutely nothing; and every pound of coal, which in the act of combustion enters into chemical combination, renders more than two and a half pounds of oxygen available for power. We cannot look to water as a practicable source of oxygen, for there it exists in the combined state, requiring expenditure of chemical energy for its separation from hydrogen. It is in the atmosphere alone that it can be found in that free state in which we require it, and there does not appear to me to be the remotest chance, in an economic point of view, of being able to dispense with the oxygen of the air as a source either of thermo-dynamic or electro-dynamic effect. But to use this oxygen we must consume some oxidisable substance, and coal is the cheapest we can procure.

"I have hitherto spoken of coal only as a source of mechanical power, but it is also extensively used for the kindred purpose of relaxing those cohesive forces which resist our efforts to give new forms and conditions to solid substances. In these applications, which are generally of a metallurgical nature, the same wasteful expenditure of fuel is everywhere observable. In an ordinary furnace employed to fuse or soften any solid substance, it is the excess of the heat of combustion over that of the body heated, which alone is rendered available for the purpose intended. The rest of the heat, which in many instances constitutes by far the greater proportion

of the whole, is allowed to escape uselessly into the chimney. The combustion also in common furnaces is so imperfect, that clouds of powdered carbon, in the form of smoke, envelope our manufacturing towns, and gases, which ought to be completely oxygenised in the fire, pass into the air with two-thirds of their heating power undeveloped. Some remedy for this state of things, we may hope, is at hand, in the gas regenerative furnaces recently introduced by Mr. Siemens.

"Not less wasteful and extravagant is our mode of employing coal for domestic purposes. It is computed that the annual consumption of coal in dwelling-houses amounts in this country to upwards of twenty-nine millions of tons. If any one will consider that one pound of coal applied to a well-constructed steam-engine boiler evaporates ten pounds or one gallon of water, and if he will compare this effect with the insignificant quantity of water which can be boiled off in steam by a pound of coal consumed in an ordinary kitchen fire, he will be able to appreciate the enormous waste which takes place by the common method of burning coal for culinary purposes. The simplest arrangements to confine the heat and concentrate it upon the operation to be performed, would suffice to obviate this reprehensible waste.

"The increase of the earth's temperature as we descend below the surface is a subject which has been discussed at previous meetings of the British Association. It possesses great scientific interest as affecting the computed thickness of the crust which covers the molten mass assumed to constitute the interior portions of the earth, and it is also of great practical importance as determining the depth at which it would be possible to pursue the working of coal and other minerals. The deepest coal-mine in this district is the Monkwearmouth Colliery, which reaches a depth of eighteen hundred feet below the surface of the ground, and nearly as much below the level of the sea. The observed temperature of the strata at this depth agrees pretty closely with what has been ascertained in other localities, and shows that the increase takes place at the rate of 1° Fahr. to about sixty feet of depth. Assuming the temperature of subterranean fusion to be 3,000°, and that the increase of heat at greater depths continues uniform (which, however, is by no means certain), the thickness of the film which separates us from the fiery ocean beneath will be about thirty-four miles—a thickness which may be fairly represented by the skin of a peach taken in relation to the body of the fruit which it covers. The depth of 4,000 feet, which has been assumed as the limit at which coal could be worked, would probably be attended by an increase of heat exceeding the powers of human endurance. In the Monkwearmouth Colliery, which is less than half that depth, the temperature of the air in the workings is about 84° Fahr., which is considered to be nearly as high as is consistent with the great bodily exertion necessary in the operation of mining. The computations, therefore, of the duration of coal would probably require a considerable reduction in consequence of too great a depth being assumed as practicable.

"At the last meeting of the British Association in this town, the importance of establishing an office for mining records was brought under the notice of the council by Mr. Sopwith, and measures were taken which resulted in the formation of the present Mining Records Office. The British Association may congratulate itself upon having thus been instrumental in establishing an office in which plans of abandoned mines are preserved for the information of those who, at a future period, may be disposed to incur the expense of bringing those mines again into operation. But more than this is required. Many of the inferior seams of coal can be worked only in conjunction with those of superior quality, and they will be entirely lost if neglected until the choicer beds be exhausted. Although coal is private property, its duration is a national question, and Government interference

would be justified to enforce such modes of working as the national interests demand. But to enable Government to exercise any supervision and control, a complete mining survey of all our coal-fields should be made, and full plans, sections, and reports lodged at the Mining Records Office for the information of the legislature and of the public in general.

"Before dismissing the subject of coal, it may be proper to notice the recent discovery at Berthelot of a new form of carburetted hydrogen possessing twice the illuminating power of ordinary coal gas. Dr. Odling has since shown that the same gas may be produced by mixing carbonic oxide with an equal volume of light carburetted hydrogen, and exposing the mixture in a porcelain tube to an intense heat. Still more recently, Mr. Siemens has detected the same gas in the highly-heated regenerators of his furnaces, and there is now every reason to believe that the new gas will become practically available for illuminating purposes."

After referring to the dynamical theory of heat to the subject of gunnery, the discovery of the source of the Nile, and to Mr. Darwin's theory on the origin of species, Sir William concluded by observing that "the tendency of progress is to quicken progress, because every acquisition in science is so much vantage ground for fresh attainment. We may expect, therefore, to increase our speed as we struggle forward; but however high we climb in the pursuit of knowledge we shall still see heights above us, and the more we extend our view, the more conscious we shall be of the immensity which lies beyond."

The following were among the papers read in the sections named:—

Section C.—Geology. *President*, Professor W. W. Smyth, F.R.S., F.G.S. *Secretaries*, G. F. Boyd, J. Daglish, T. Sopwith, F.R.S., and H. C. Sorby, F.R.S.

The President.—Opening Address.

N. Wood, J. Taylor, J. Marley, and J. W. Pease.—On Coal, Coke, and Coal Mining in Northumberland and Durham.

J. P. Lesley.—On the Coal-measures of Sydney, Cape Breton.

G. B. Forster and J. Daglish, F.G.S.—On the Magnesian Limestone of the county of Durham.

Prof. Harkness, F.R.S.—On the Hornblendic Greenstones and their relations to the Metamorphic and Silurian Rocks of the county of Tyrone.

H. C. Sorby, F.R.S.—On Models illustrating the contortions in Mica-Schist and Slate.

Prof. Ansted.—On a deposit of Sulphur in Corfu.

Prof. Ansted.—On the Metamorphic Origin of the Porphyritic Rocks of Charnwood Forest.

C. Moore.—On the equivalents of the Cleveland Hill Ironstones in the West of England.

C. Moore.—On the Organic contents of the Lead Veins of Allenheads and of Yorkshire.

W. Bainbridge.—On the Penine Fault.

M. Dunn.—On Coal in the Red measures.

T. A. Readwin.—On the recent Discovery of Gold near Bala Lake, Merionethshire.

A. Bryson.—On the Origin of Granite.

Prof. J. Thompson.—On the Origin of the jointed prismatic Structure in Basalts and other Igneous Rocks.

J. Marley.—On the occurrence of Rock Salt at Middlesbro'.

C. Attwood.—On the Weardale Iron Ores.

T. Sopwith.—On a section of the strata from Hownesgill to Cross Fell.

Section B.—Chemical Science. *President*, A. W. Williamson, F.R.S. *Secretaries*, H. L. Pattinson, J. C. Stephenson, Prof. Liveing, F.C.S., and A. Vernon Harcourt, F.C.S.

The President.—Opening Address.
J. Cowen.—Fire Clay Goods.
T. Richardson.—On the presence of a Salt of Baryta in Colliery Water.
G. Gore.—On a New Gas Furnace for Scientific and Practical Purposes.
J. C. Stevenson, R. C. Clapham, and T. Richardson.—Chemical Manufactures.
J. Pattinson.—On the various kinds of Pyrites used on the Tyne and neighbourhood for the Manufacture of Sulphuric Acid.
J. L. Bell, T. Sopwith, Dr. Richardson, and T. Spencer.—Report on the Metallurgy of the district.
E. Riley.—On Titanium in Iron.
J. Pattinson.—On a deposit in Blast Furnaces.
J. Pattinson.—On Zinc, Nickel and Cobalt in Cleveland Ironstone.
J. L. Bell.—On Aluminium.
Dr. Matthiessen.—Report on the Chemical Nature of Alloys.
Dr. Richardson.—On the separation of Lead and Antimony.
W. Baker.—On the Impurities contained in Lead, and their technical uses.
W. Crookes.—On Thallium.
J. L. Bell.—On Thallium.
Dr. Stevenson Macadam.—On the Analysis of Chinese Iron.
Dr. Davey.—On the Slaking of Quick-lime.
Dr. Jenner.—On Impurities in Lead.
Dr. Murray Thompson.—On New Zealand Lignites.
Dr. Macadam.—On the Manufacture of Superphospates and dissolved bones.
R. C. Clapham and J. Daglish.—On the Minerals and Salts found in Coal-pits.

SECTION G.—Mechanical Science. *President*, Rev. Robert Willis, F.R.S. *Secretaries*, P. Le Neve Foster, J. F. Spencer, and P. Westmacott.
The President.—Opening Address.
C. T. Porter.—Richard's Indicator for Steam Engines.
P. Westmacott and J. F. Spencer.—Engineering Manufactures of the Tyne and neighbouring districts.
C. W. Siemens.—On Regenerative Gas Furnaces as applied to Iron Works.
C. M. Palmer.—Iron Shipbuilding on the Tyne and neighbouring districts.

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## PROFESSOR SMYTH'S ADDRESS.

Mr. Smyth commenced by stating that the town of Newcastle being naturally associated in men's minds with a particular geological formation, doubtless many of the visitors to this centre of the coal trade would have come with the expectation of not only hearing communications on various branches of geological science, but more especially of adding to their knowledge of the carboniferous strata. "The Carboniferous system is commonly divided into three principal divisions, namely, the Carboniferous Limestone, the Millstone Grit, and the Coal-measures. The Carboniferous or Mountain Limestone, the oldest group of strata for our consideration, might be hastily passed over, but for its presenting in this northern district a transitional type between Scotland and the south of England, no less important in its commercial aspect than interesting to the geologist. Turn to the Mendips, to Wales, or to Derbyshire, and we find the Carboniferous Limestone constituted almost exclusively of actual limestone strata, amounting to from three or four hundred to above fifteen hundred feet in vertical thickness, and never exhibiting other than the smallest traces of beds of coal. But in Yorkshire a change sets in, the carboniferous action, if I may so term it,

applies the thin end of the wedge, and small seams of coal of but little value are intercalated among the beds of limestone, and associated with a large proportion of shale and sandstone, stratified with a remarkable regularity. Advancing northward these seams increase in number and importance through the great moorland region, which culminates in Cross Fell, the same strata rising from far beneath our feet as we stand here on the Lower Tyne, emerge to the daylight, and compose the substances of the Penine chain, which, with its lofty and heather-purpled undulations, form the broad dividing ridge of Northern England. In the region of Weardale and Alston, where, in the becks and burns, and in the great escarpment which towers above the valley of Eden, excellent exposures of the strata invite our study, the shales are often very similar to those of the Coal-measures, though containing but few vegetable remains; the sandstones and grey beds frequently exhibit stems and fragments of plants familiar to us in the overlying strata, and the coal seams are *crow-coal* or anthracite, resting in a bed of indurated silicious silt or of clay. Northward, however, of the great fault which runs nearly parallel to, but south of the Newcastle and Carlisle Railway, the coal seams become, as it appears, suddenly bituminous, the lower division of the limestone admits more numerous intercalations of shale, sandstone, and coal; and when we follow it to the upper district of the Tyne, and beyond the river Coquet, the violent folding and contortion to which the strata have been subjected bring into view new basins or fields of coal. The true position of these is far beneath our ordinary measures, and has been recognised as such in Scotland, where they attain a vast importance. In the Berwick district, it would appear that about four hundred fathoms of Carboniferous Limestone measures have been detailed below the Whin Sill, or basaltic bed, and about one hundred fathoms above it, including in all twelve seams of coal of from two to four feet each. Certain of these, the Scremerston seams, appear to be remarkable in having a limestone roof. Let us pass to the next overlying group. The Millstone Grit, or farewell rock, as it is sometimes called by colliers, embraces a series of strata unproductive in coal, and in which conglomerates, and coarse and silicious grits often preponderate. With this rugged crown many of the fell tops are capped; but before it bends downwards to pass under the first strata of the Coal-measures, we may frequently find with it strata of shale and sandstone and fire-clay, roughly similar to those of the true measures, but presenting to a practised eye peculiarities of structure and colour. As we descend eastward from the higher ground of the moorlands, on the edge of which the first Brockwell seam of coal is traced, and as we find new and higher seams constantly succeeding, and the strata inclined regularly towards the sea, we pass into the midst of that tract which, extending from the river Coquet on the north to near the Tees on the south, for fifty miles in length, forms the great northern coal-field. The greatest thickness attained by this formation is probably not more than two thousand feet; but it would be vain for me, within a limited time, to offer you details of the strata. Let it suffice to say that, in this thickness, there exist, associated with shales of many varieties and with fine-grained sandstones, some fifty-seven beds of coal, from an inch thick upwards, comprising in all seventy-five feet of coal; but that what are considered the workable seams are twelve in number, giving an aggregate of about fifty feet of coal. On the east the Coal-measures are overlaid, in a line running from South Shields past Houghton-le-Spring to near Bishop Auckland, by the Permian series, represented by the Magnesian Limestone and the Lower Red Sandstone, that unequal and water-bearing bed which forms the great obstacle to the sinking of shafts to the underlying coals. Prejudice, it is well known, even after the difference of these strata from the Mountain Limestone was proved, long contended that the coal would not be found continuous beneath the Magnesian Limestone; and it is still

asserted that the seams have proved inferior when they pass beneath it, as shown especially by the failure in certain tracts of the five-quarter and Hutton seams. But no sufficient reason is apparent why such deterioration is not rather to be ascribed to that variation in quality which all seams are found to undergo when followed over a large area, than to the soil influence of an unconformable upper formation. As regards the physical agencies which have impressed its present form on this great coal-field, I would remark that they appear to have acted with upheaval in a north and south direction, as evinced by the regular strike over a great length of country. This was accompanied or followed by transverse fractures resulting in several very pronounced lines of fault. Let us now cast a brief glance on the theoretical side of the subject. Upon the mode of origination of the limestone, the shale and the grit or post, little difference of opinion is now entertained. That the coal itself has been formed purely from vegetable matter can no longer be questioned. The view originally propounded by De Luc that the vegetation now composing our coal seams grew on the soil which actually forms the bed or 'thill' of the seam has met with very general acceptance, notwithstanding the difficulty of adopting it in certain exceptional cases. That this dense mass of vegetation swelled over an area frequently subjected to depression beneath the neighbouring waters admits of but little doubt. Such an hypothesis serves to explain, not only the equable covering of the coals with their roofs of muddy or sandy matter, afterwards consolidated into shale and grit, and exhibiting to our gaze the remains of mollusca and fishes which tenanted the waters of those depressions, but indicates also the mode in which certain seams have been divided by a parting almost imperceptible in one place, but amounting to many feet in another. The well-known Bustey Bank seam of the western district, some five feet thick, including a clay band of eleven inches, is thus divided in a distance of two or three miles, by the increase of the parting to eighteen feet, into the stone coal and the five-quarter at Garesfield Colliery. A still more remarkable instance is the Tow Law seam at these works, six feet three inches thick, which, by the increase of a parting as it goes eastward, exhibits at Bowden Close Colliery, only three miles away, two seams divided by no less than sixteen fathoms of ground, in which beds of sandstone or pert, and their seams of coal, have been intercalated. Such partings, when composed of shale, are often one mass of stigmarine impressions, and thus form no exception to the generally important part which that fossil plays as the root of the chief plant of the coal; but when the partings consist of fine-grained clean sandstone, showing no trace of rootlets, I confess that the appearance of bright solid coal resting upon them seems to me to demand some other explanation. Instances of this kind, observed in South Staffordshire and in the Whitehaven collieries, induce me to think that the material must in some cases have been introduced between the laminæ, and sometimes even diagonally athwart them, subsequently to the solidification of the coaly matter. But there are several curious phenomena as to which a doubt frequently arises, whether they are due to action during or after the formation of the coal, and deductions of no small practical importance sometimes depend on the question. Thus Mr. Hurst has given a very exact account of irregularities, especially *swellies*, or narrow depressions in the low main coal, which appears to have been formed prior to the deposition of the upper seams. On the other hand, Mr. Marcus Scott has excellently described a broad valley of denudation which was eroded in the coals of the Shropshire field, and filled in with higher unproductive measures. Again, with some of the slips and faults or troubles we may sometimes observe both coal and ironstone beds so to change in approaching them, or to vary so much on opposite sides of them, that, whilst in some few cases we may be led to suspect their contemporaneity with the beds themselves,

there are many more which we cannot explain without supposing that the coal must, at the time of the disruption, have been moulded and squeezed in an almost plastic condition."

Mr. Smyth concluded with some remarks on the determination of plants in coal, especially referring to the labours of Hutton, Professor Phillips, Mr. Binney, and Mr. Hull on this subject.

## THE MAGNESIAN LIMESTONE OF THE COUNTY OF DURHAM.

In this paper it is stated that, as the Magnesian Limestone covered a considerable portion of the northern coal-fields, its study was most interesting to those engaged in the mining operations of the district. This arose from its important bearing, not only in geological, but also in physical conditions. Of the latter, one of the most marked was the large quantity of water met with in shafts that had been sunk through the limestone for the purpose of winning the coal below. In all sinkings through Magnesian Limestone there were feeders of water, chiefly from gullets and fissures, and if the shaft were not drained the water rose to a point which generally remained constant. Although the line commenced at the sea level, it neither continued in this plane nor followed the line of stratification, nor the undulations of the surface, but rose almost uniformly with the surface as it passed inland. The circumstances which favour the remarkable accumulation of water in the limestone, and the rapidity with which it is drained off into pits sunk through it, are due to several causes, some of which are peculiar to this formation, and perhaps to the district. They are—1st. The arrangement of the beds of stratification; 2nd. The contour of the country; 3rd. The permeability to water of this formation. The beds of stratification dip towards the sea at an angle somewhat more inclined than the surface of the ground, so that on this line of section the Magnesian Limestone crops out with a bold escarpment. The boldness of this escarpment is no doubt to a certain extent due to the soft nature of the "yellow sand" lying immediately below it, this sometimes reaching a thickness of fifty feet, extends over the flat base to a considerable extent beyond the limestone, and being thoroughly pervious to water, forms a natural absorbent for all the drainage of the district around. In addition to this over the country extending from the outburst of the limestone to the sea, large fissures intersecting in all directions the limestone, form so many channels of communication between the surface and the bed of "yellow sand," down which the surface drainage, and even in some instances small streams, pass freely.

## ON THE PORPHYRITIC ROCK OF CHARNWOOD FOREST.

The object of this paper was to show that the rocks, consisting of syenites, granites, and others of the appearance and character generally regarded as igneous were really of the same data as the slates with which they seem to alternate. The Professor said it was clear either that the slates were originally a continuous submarine deposit, of which certain parts have since become porphyries, or that the slates were formed from clay at successive intervals of time—the time being long enough, and the change of level great enough, to admit of the conversion of clay into slate on each occasion, while each interval was also marked by the outpouring of igneous rocks. Or else, that the slates were cracked in the place of their bedding, and the granite thrust through without disturbing the dip. The Professor himself inclined to the theory of metamorphism. He disputed the propriety of attributing these slates and other rocks of Charnwood to the Cambrian period. All we know is the fact of the great mass of them being clearly the result of some older condition of the earth, so that they afford no evidence whatever of the beginning. Professor Ansted concluded by pointing out that the existence of any fluid nucleus of the earth near

the surface, or even within many hundred miles, is altogether contradicted by the latest physical investigations; that the existence of a few good instances of passage beds from slate to granite is sufficient proof of the possibility of that metamorphism of which there are so many other indications, and that the study of one small typical district, like the one in question, is of itself more instructive and useful to the geologist than larger illustrations, though these also must be obtained before he can arrive at any general conclusion.

In the discussion on this paper, Professor Jukes observed that it was a mistake to suppose that Plutonic or molten rocks—rocks that so closely approximated to absolute fusion, as that their particles could re-arrange themselves and formed crystalline masses—were eruptive rocks. He believed it was impossible to have large intrusive masses of genuine igneous rock intruding into other rock without producing any similar amount of alteration.

## ORGANIC CONTENTS OF LEAD VEINS.

In this paper Mr. Moore called attention to the fact that the contents of mineral veins are often as varied in their character as they can well be; being in general highly mineralised and dense, at other times varying from a conglomeratic infilling to materials more nearly approaching the marls and clays of stratified deposits. A close examination of the latter, at whatever depth they may be found, gives evidences of having been derived, some probably from the denudation of older rocks, which have been re-deposited with their organic contents in the then open fissures of the veins; others from younger deposits, showing that the rocks in which the veins are found were then either at the bottom of the ocean or within its influence. That the deposit in the veins was at times very slow, is shown by some of the clays being composed of as thin laminæ as if deposited in horizontal beds. On having the specimens of the material before them, nothing could look more unpromising to the eye of a palæontologist, and yet from 160 to 170 species have been found derived from Carboniferous Limestone veins alone. The first step in their discovery is to wash the vein stuff, floating away as much as possible of the finer material, and in the sediment remaining after the washing the organic remains are to be sought for. So abundant are they, in some instances, that ½ oz. in weight has yielded as many as 156 specimens; whilst others still remain in the deposit. Recently, through Mr. Bewick, he received eight samples from Allenheads; these being much mineralised, organic remains were found in three samples only; but, in six others more recently sent, and more carefully selected, he had found remains in every instance. The lowest depth at the Allenheads Mines in which he had yet traced organisms was 678 ft., but there appeared no reason for supposing that they might not be obtained from the lowest workings. In a former set of samples, sent to him from Weardale by Mr. Cain, thirteen out of twenty-nine were fossiliferous. At Alston Moor Mines, in Cumberland, they had a deposit of the same mineralogical character, and containing precisely the same genera and species. After referring to other mines, he continued that he had stated that identical organisms occurred at certain depths at Alston Moor and Weardale, placing them, probably, on the same horizon. It might be a very difficult matter for investigation, but he believed it possible, by a consideration of this question, that certain horizons in mines might be established, not so clearly, of course, as in stratified deposits, but such as might enable a mine manager to know his position relatively with mines in other neighbouring districts, and thus know whether he might, and at what distances, be passing into barren or paying ground. Further, he believed those investigations would assist to establish the fact that minerals are due, not to plutonic, but to a very opposite agency.

## ON THE PENINE FAULT.

In describing this fault the author traced the igneous rock for nearly twenty miles along the base of the carboniferous chain, showing it to be of varied form and elevation, spread out into flat spaces, heaped up into lumpish hills, and rising to the skies in majestic graceful cones. The greenstone passed into slate of differing hardness, and both were found indiscriminately along the line. There were no organic remains in either. The amorphous greenstone was a dull dark substance, often liable to decomposition, but often very compact. On the western side of Dufton Pike occurred beds of granite apparently in round or oval deposits or bellies, and also in the beck to the north, like that of Shap Fell. Smooth boulders of this granite and of basalt were dispersed along the flanks of the chain northward. The granite on the Pike, and further south, contained mica. There were also veins or dykes across the line of grey wacke, as at Gale, near Melmerby, containing felspar and talc. There was no appearance of volcanic craters. Various conjectures might be hazarded as to the manner in which this mass of igneous matter was ejected. The wonderful forms of Merton and Dufton Pikes seemed to prove not only that they began and completed their full stature after the elevation of the chain, and not only that fabrics like these could not at any subsequent period have been submitted to any serious aqueous disturbance, but they seemed to indicate separate volcanic rents. There was no evidence in any part of the line of any extreme violence of explosion, and these pikes would probably not have survived in their present integrity any such fits of power. Their sides and summits must have been broken, and their contents reduced to the chaos apparent in other portion of the line. The growth of cones would require longer periods of time than that of pikes. Some connection between the Penine Fault and the Ninety Fathom Dyke had often been suggested. The dyke was first seen at Cullercoats, on the Northumberland coast, where its effect was very conspicuous in throwing down the Magnesian Limestone, and the underlying stones from ninety to a hundred fathoms. As there was not a vestige of coal in the Penine Chain, its elevation and the crisis of the Penine Fault must have occurred either before the deposition of the coal or after the chain had been denuded of coal already deposited. But at the Tynedale Fault, coal was thrown down from a considerable height. It could hardly, therefore, be doubted that coal once existed throughout the chain upon the Millstone Grit, and was washed off during the partial submergence of the chain. In that case it would follow that the Tyndale Fault, occurring after the deposition of the Magnesian Limestone, and before that of the New Red Sandstone, was older than the Penine Fault, and that the latter fault, with all its volcanic consequences, might have occurred within the same geological epochs, but after the effects produced by the Tynedale Fault. This denudation of coal would, of course, imply an intermediate subsidence of the Mountain Limestone system, during which the coal of the chain, both north and south, of its depression and burial along the line of the Tynedale Fault, would be washed away. It did not follow that the subsidence should be excessive. There appeared to be direct evidence in the disturbed magnesian conglomerates near Brough that the Penine Fault, which followed the final elevation of the chain, may have occurred after the dislocation of the Magnesian Limestone at Cullercoats. The existence of the Ingleton coal, which may, from causes operating on a limited tract, have escaped destruction, seemed to show that the Tynedale Fault must have preceded the Penine Fault; but after all that had been said there was abundant scope for further observations and reasoning on this difficult subject.

Professor PHILLIPS said it might be possible that on careful scrutiny a difference of age might be discerned between the Tynedale Fault and

the Penine range, but nothing could remove his conviction that as physical phenomena they were connected. The causes producing so symmetrical a fracture might not all have operated at the same time, but they must have been in operation within the same geological period, and must have been dependent on internal conditions. He wished for a special examination of the mineral constitution of the rocks which Mr. Bainbridge regarded as volcanic rocks, for he had difficulty in comprehending their volcanic character from anything he had seen of them, and only the shape seemed to indicate even abnormal volcanic mountains. He was inclined to think they were not such as would fairly come within the title of volcanic mountains, and that there was no proof of the rock having ever been submitted to the action of any water except rain water. He could easily conceive that, in the course of an immensity of time, decomposition on the surface of the mountains would produce the effects that were now seen, and that it was possible to have a conical figure produced upon rocks of a sedimentary origin.

## ON THE OCCURRENCE OF ROCK SALT AT MIDDLESBRO'.

About four years ago, Messrs. Bolckow, requiring a good deal of fresh water in connection with their iron-works, commenced to sink a well or shaft, in order to obtain a supply of it. This shaft was carried to a depth of one hundred and eighty feet, but the supply not being sufficient, they commenced about a year ago to put down a borehole. The rock salt was first pierced at a depth of twelve hundred and six feet, and the bottom is not yet proved, but is already one hundred feet into it. The quantity and quality of the brine had not yet been fully tested, but the subjoined has been given as an analysis :—Chloride of sodium, 9·163 per cent.; sulphate of lime, 3·09 per cent.; sulphate of magnesia, 0·08 per cent.; sulphate of soda, 0·10 per cent.; silicia, 0·06 per cent.: oxide of iron, trace; moisture 0·04 per cent. On the north, at Castle Eden Colliery, the Coal-measures are overlaid by the Permian; and at Oughton boring, near to the Tees, the Trias has been bored in to some five hundred feet—the Hutton coal-seam at Castle Eden Colliery being some seven hundred feet below the sea level, and the salt at Middlesbro' about twelve hundred and fifty feet. On the south side of the Tees, the Lower Lias is soon put on and capped by the Upper Lias and Oolite measures, the measures dipping both to the south and north from the Tees.

## ON THE WEARDALE IRON ORES.

In this paper Mr. Attwood observed, that in Weardale, iron ores, occurring as they do under the two different forms of spathon or sparry carbonate, and of hydrated peroxides, have certainly been all at first deposited as carbonates, and have passed into the state of oxides and of hydrates by the joint effects of atmospheric and of aqueous action. Examples of every stage of the transition present themselves in all directions, and there are also met with, from time to time, abundant proofs that, whilst the carbonates deposited are more or less rapidly passing into the hydrated condition, a fresh deposit of carbonates is continually going on in the mines in cavernous interstices, and on the roofs and sides of ancient workings, very much in the same way as stalactites and stalagmites are deposited. Upon one occasion there was found protruding, for five or six inches, from a block of pure and large-grained sparry carbonate of iron, a rod of malleable iron, of about a quarter of an inch in diameter, of which the other end was firmly embedded to about the same depth in the block, which had just before been broken from the mass of it, which was incrusting the walls and roof of an ancient drift, but which block must have been formed within one or two centuries.

# Abstracts and Reviews.

## THE NORTHERN COAL-FIELD.

*Report on Coal, Coke, and Coal Mining; forming one of a Series of Papers on the Resources of the Three Northern Rivers, Tyne, Wear, and Tees. North of England Institute of Mining Engineers.*

Among the numerous valuable contributions to our knowledge of the mining and metallurgical industry of the northern counties drawn forth by the Newcastle meeting, none can be considered as more interesting or valuable than this Report, prepared by the North of England Institute of Mining Engineers. As the Report itself will doubtless be consulted by all seriously interested in the subject, we shall content ourselves here with giving a brief abstract of its contents, which are classed into distinct sections, under the following heads :—

1. Geological Description of the Northern Coal-Field including the Dykes intersecting it, and other prominent features.
2. On the Economic and Industrial Uses of the various Beds of Coal in the North of England Coal-Field, and their local distribution.
3. The early History of the Coal and Coke Trade, more particularly referring to this District.
4. A brief Statement of the Development of the Coal and Coke Trade up to the present time, including some important Statistics.
5. An account of New Discoveries and their Application, explaining the manner in which they affect the Coal and Coke Trade.
6. On the Sinking of Pits, and the Drainage of Mines.
7. On the Mode of Working Mines.
8. On the Ventilation and Lighting of Mines.
9. On the Underground Conveyance of Coal.
10. On the Effects produced by the Introduction of Railways, Locomotives, Screw Steamers, and Inland Competition on the Commercial Character and Condition of the Northern Coal Trade.
11. On the Duration of the Coal-Field.

Passing over the 1st Section, we find, in No. 2, a most lucid synopsis of the various classes of coals found in the Northumberland and Durham coal-fields, classed as follows; (1) Household Fire Coal; (2) Gas Coal; (3) Manufacturing Coal: (4) Steam Coal; (5) Coking Coal.

(1). *Household fire coal* would probably be first in request, and those beds which cropped out to the surface, would be first used, whether best adapted for domestic purposes or not. Hence in the earliest period of the coal trade, all the beds were indiscriminately worked and used as household fire coal; their use depending upon the comparative facilitity with which it could be procured. As the means of working other beds were discovered, and the various purposes for which coal was required became numerous, that description best adapted for the specific purpose for which it was required would be worked and used; which, for house firing, would be that which, when burnt, left no residue, or produced few ashes, particularly white ashes, which gave out the greatest quantity of heat under those conditions, and burnt in a steady and uniform manner. The best household fire coal was for many years produced from the High Main coal of the Tyne, the immediate colliery being Wallsend, and hence the origin of the designation "Wallsend," to distinguish the "Best Household Fire Coal." This coal was also produced at the various collieries of Percy Maine, Walker, Heaton, Willington, &c., on the Tyne. It was not that coal of similar quality, was not produced on the Wear and Tees, but, that the coal on the Wear being mixed with and sold with other coals of an inferior

quality, no coal of that river, or indeed in the whole coal-field, bore such an excellent character or sold at such high prices as the "Wallsends" of the Tyne.

(2). When gas was introduced, a coal was required which produced in its combustion the greatest possible quantity of gas, purity being also an important object, together with cheapness. The best gas coal is produced from the Hutton seam at the Felling, Pelaw, Pelton, Peareth, &c., collieries; also from the same seam on the Wear, and the Brockwell seam, on the Tees.

(3). On the application of steam machinery to manufactories, a coal which produced the greatest amount of heat, without destroying the fire bars of the engine furnaces, and leaving as little residue as possible, was preferred. This was called *manufacturing coal*, and is obtained from the lowest seam in the Auckland district.

(4). When steam-engines, and, particularly, steamboat engines became numerous, a coal adapted for raising the largest quantity of steam, open burning, compact and hard, not liable to break into small coal and form dust, and which, when exposed to different temperatures of climate, did not fall to pieces, was required. Then a class of coal called *steam coal* was in demand. It also is produced from a tract of the Hutton seam in the Hartley district, and it is a curious coincidence that this Hutton seam is not only continuous throughout the whole extent of the coal-field, but that it also yields the *best* description of three different varieties of coal, viz.:—the *best household*, the *best gas*, and the *best steam coal*.

(5). When the use of locomotive engines on railways was introduced, an extraordinary demand arose for *coking coal*, or that description of coal which produced the largest quantity of coke free from sulphur, and leaving no clinker on the grate bars. The best coking coal is got from the lower beds of the Tyne. The Newcastle coal-field is essentially a bituminous coal deposit. It does not contain any anthracite, nor, with the exception of a thin bed in a limited locality, does it contain any cannel coal.

Passing over section 3, the statistics given in No. 4 show that the increase in the total vend of coal from 1791 to 1862 was 8,055,185 tons. In 1861 the number of collieries worked was 13 less than in 1860, but a million more tons of coal were raised. The present make of coke in Northumberland and Durham is estimated at 2,519,545 tons, which alone necessitates an annual consumption of 1,000 acres of four-feet seam of coal.

From No. 5 we find that the system of screening was first introduced in 1741, by Mr. W. Brown, and, although this produced a superior article, it may be questioned if it was an advantage to the coal trade at that period, for it was the means of causing immense quantities of small coal to be burnt to waste, as being unsaleable. The most prominent feature in the changes of the coal trade, particularly on the river Tees, has been the discovery of the Cleveland ironstone, its bearing on the coal trade of that district, from the great increase in the number of blast-furnaces, being so direct and important.

In No. 6 it is stated that, apart from the use of more powerful machinery, little improvement has been made in the sinking of pits during the last thirty or forty years. The chief difficulties met with in sinking arise—(1) From quicksands, immediately below the surface, which are generally dealt with by piling; (2) From quicksands underlying the Magnesian Limestone, which are of a much more difficult nature owing to the difficulty of driving piles through the indurated sandstone frequently met with. (3) From large feeders, met in sinking through the Magnesian Limestone, and many of the Coal-measure sandstones, and which occasionally give rise to a large expenditure.

In No. 7 it is pointed out that the ordinary mode of working coal seams, in the early period of coal mining, was to get out as much coal as

possible, leaving a pillar just sufficient to support the superincumbent strata. The bad effects of this mode of working being perceived, it was commenced removing the pillars entirely, simultaneously with working the whole coal, and this system has been in operation up to the present time, with the difference that a much larger description of pillar is now left than formerly, thus forming a sort of connecting link between the "board and wall" system, and that of the "long wall."

In No. 8 the ventilation and lighting of mines is discussed. The former has been effected in the following ways:—(1) Natural Ventilation, in which no artificial means are employed. (2) By Waterfall, which had the effect of causing a considerable current, but was objectionable, as the water was again to be raised to surface. (3) Mechanical Ventilation, by air pumps. (4) Steam Jet. (5) Furnace. It is remarked that of the many means of ventilation, devised from time to time, rarefaction, by the use of the ordinary furnace, possesses the advantages of greater cheapness, regularity, and efficiency.

Passing over Nos. 9 and 10, it is stated in No. 11 that, as will be seen from the observations made, a calculation as to the duration of the coal field is attended with more than ordinary difficulty. It is not known how far beyond the seashore the beds dip underneath the sea, or at what distance beyond the line of the coast the greatest depression of the coal beds will be found, and until more extensive explorations determine this, we are completely at fault as to the quantity of coal lying underneath the sea. From the difficulties to be encountered in approaching such an inquiry, the attempt may, for a vast period of time, be considered at least premature.

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## THE BOVEY TRACEY LIGNITE.

*The Lignites and Clays of Bovey Tracey, Devonshire.* By William Pengelly, F.R.S., F.G.S.—Memoir read before the Royal Society, November 21, 1861.

The lignite deposit of the Bovey Heathfield has long been one of the obscure points of English geology. It has certainly long been the settled conviction of geologists that this lignite is of vegetable origin, the clays and sands had been furnished by the disintegration of the Dartmoor granite, and that the whole is of supercretaceous age; but its exact chronology had not been determined, and it was suggested to be of Post-pliocene origin. It was also stated by Sir H. de la Bèche, so recently as 1839, to contain *no* organic remains. The desirability of fully investigating this lignite deposit being brought under the notice of Miss Burdett Coutts, Mr. Pengelly was furnished by her with the necessary means for undertaking the work.

In this memoir of Mr. Pengelly and Professor Heer, the true position of these lignites in the geological series is determined, and the vexed question of their age settled, it being decided that they are contemporaries of the "Hempstead Beds," in the Isle of Wight, first discovered by the late Professor Edward Forbes, and which, although always regarded by him as Upper Eocene, have recently been grouped amongst the Lower Miocene. This is, however, merely a question of classification, and wherever they are the Bovey beds must accompany them.

These investigations have also been so far successful that, instead of there being no organic remains, they have "added forty-nine species to the fossil flora of this country, of which twenty-six are new to science,—recognised the first traces of animal life which the deposit has yielded,—detected another British fragment of the Miocene page of the earth's history, which, until 1857, was supposed to be totally unrepresented in England,—taken us back to a remote period when the slopes of Devonshire were clothed with a luxuriant subtropical vegetation,—and separated, by a

wide chronological hiatus, the lignite and associated beds from the gravels overlying them—a hiatus evidenced by the dissimilarity and unconformability of the two series, by a change in the direction by which detrital matter reached the Bovey area, by great vertical displacements of the lower series, followed by denudation of the consequent surface-inequalities prior to the deposition of the upper, and by the exchange of an extinct flora, requiring a high temperature, for an existing one; which is now confined to arctic and alpine regions."

The economic importance of these deposits is trifling. The lignite was formerly used in large quantities in an adjoining pottery, but now little is employed there, and an offensive sulphurous smell, which it emits during combustion, prevents its general domestic use. The refuse matter, consisting of clay and waste lignite, is lodged on the surface around the pit. Iron-pyrites occur in it in considerable quantities; and spontaneous combustion is common in fresh refuse. Recently it was in contemplation to coke it for smelting the iron ores found in the neighbouring parish of Ilsington. Indeed blast-furnaces have lately been erected, by a "London Company," for this purpose, under the superintendence of Mr. S. B. Rogers (whose death, at Newport, Monmouthshire, we announce elsewhere). The furnaces were, however, never lighted, and are not likely to be by any prudent people.

Mr. Pengelly is well known as the most distinguished geologist in the two Western Counties; and in this memoir he has added to the obligations which we already owe to him as the most persevering and successful contemporary worker in the field of Devonian geology—which, indeed, he has almost made his own.

## THE BOARD OF TRADE RETURNS.

The "Accounts relating to Trade and Navigation of the United Kingdom, for the month ended 31st July, 1863, and seven months ended 31st July, 1863," have been issued by the Statistical Department, Board of Trade.

**IMPORTS.**—The quantities and relative increase and decrease of the imports of metals, metallic ores, and mineral products, for the month and seven months ended 31st July, have been as follows:—

| | Month ended 31st July. | | | Seven Months ended 31st July. | | |
|---|---|---|---|---|---|---|
| | 1862. | 1863. | Increase (+) or Decrease (—). | 1862. | 1863. | Increase (+) or Decrease (—). |
| Brimstone ... ... cwt. | 173,411 | 38,049 | —135,362 | 676,896 | 384,034 | —292,862 |
| Copper Ore ... ... tons | 7,303 | 4,859 | — 2,444 | 52,090 | 45,607 | — 6,483 |
| Copper Regulus ... ... " | 5,882 | 72 | — 5,810 | 22,949 | 11,751 | — 11,198 |
| Copper, unwrought and part wrought ... cwt. | 24,280 | 46,880 | + 22,600 | 152,220 | 148,820 | — 3,400 |
| Iron, in Bars, unwrought tons | 3,593 | 5,526 | + 1,933 | 12,072 | 16,123 | + 4,051 |
| Steel, unwrought ... " | 438 | 245 | — 193 | 2,563 | 1,013 | — 1,550 |
| Lead, Pig and Sheet ... " | 2,615 | 3,142 | + 527 | 13,097 | 14,225 | + 1,128 |
| Spelter or Zinc ... ... " | 2,114 | 1,842 | — 272 | 8,179 | 14,584 | + 6,405 |
| Tin, in Blocks, Ingots, Bars, or Slabs ... cwt. | 6,476 | 2,685 | — 3,791 | 42,384 | 22,024 | — 20,360 |
| Silver Ore... ... value in £ | 50,730 | 2,650 | — 48,080 | 194,009 | 176,981 | — 17,028 |
| Petroleum ... ...tuns | 1,383 | 3,259 | + 1,876 | 10,692 | 24,320 | + 13,628 |
| Quicksilver ... ... lbs. | — | 48,978 | — | 124,754 | 450,605 | +325,851 |

**EXPORTS.**—The quantities, declared value, and relative increase and decrease of the exports of metals, minerals, and metallurgical articles of British and Irish produce and manufactures, for the month and seven months ended 31st July, have been as follows:—

| | | QUANTITIES. | | | | DECLARED VALUE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Month ended 31st July. | | Seven Months ended 31st July. | | Month ended 31st July. | | | Seven Months ended 31st July. | | |
| | | 1862. | 1863. | 1862. | 1863. | 1862. | 1863. | Increase (+) or Decrease (−) | 1862. | 1863. | Increase (+) or Decrease (−) |
| | | | | | | £ | £ | £ | £ | £ | £ |
| Alkali: Soda ... ... ... | cwt. | 190,922 | 199,293 | 1,178,486 | 1,240,079 | 82,472 | 80,749 | − 1,723 | 493,199 | 514,688 | + 21,489 |
| Coal, Cinders, and Culm ... ... | tons | 875,481 | 791,126 | 4,690,560 | 4,671,967 | 384,017 | 347,473 | − 36,544 | 2,103,680 | 2,073,356 | − 30,324 |
| Iron, Pig and Puddled ... ... | " | 46,961 | 43,398 | 267,202 | 273,466 | 122,400 | 116,681 | − 5,719 | 715,138 | 744,349 | + 29,211 |
| Iron, Bar, Angle, Bolt, and Rod... | " | 30,181 | 27,233 | 178,012 | 184,616 | 218,183 | 209,459 | − 8,724 | 1,245,794 | 1,378,850 | + 133,056 |
| Iron, Railroad, of all sorts ... | " | 52,935 | 65,487 | 232,908 | 265,162 | 339,124 | 430,994 | + 91,870 | 1,600,583 | 1,851,150 | + 250,567 |
| Iron, Cast ... ... ... ... | " | 8,946 | 7,983 | 37,639 | 51,469 | 66,701 | 62,986 | − 3,715 | 324,674 | 427,288 | + 102,614 |
| Iron Hoops, Sheets, and Boiler Plates ... ... ... | " | 11,071 | 13,338 | 56,496 | 75,460 | 114,252 | 159,577 | + 45,325 | 561,311 | 863,775 | + 302,464 |
| Iron, wrought, of all sorts ... | " | 9,869 | 9,363 | 55,552 | 60,398 | 181,382 | 186,031 | + 4,649 | 1,085,397 | 1,151,082 | + 65,685 |
| Iron, old, for re-manufacture ... | " | 3,117 | 583 | 13,874 | 10,839 | 10,771 | 2,166 | − 8,605 | 53,591 | 40,899 | − 12,692 |
| Iron Steel, unwrought ... ... | " | 2,754 | 2,614 | 15,408 | 15,648 | 86,505 | 85,465 | − 1,040 | 507,343 | 507,374 | + 31 |
| Copper, unwrought, in Ingots, Cakes, or Slabs ... ... | cwt. | 11,075 | 24,280 | 56,307 | 162,501 | 52,366 | 112,424 | + 60,058 | 277,565 | 742,903 | + 465,338 |
| Copper, wrought or partly wrought, Bars, Rods, Bottoms, Pans, Plates, Sheets, and Nails; and mixed or Yellow Metal for Sheathing.. | " | 44,483 | 56,980 | 233,782 | 319,877 | 202,360 | 258,866 | + 56,506 | 1,091,276 | 1,457,211 | + 365,935 |
| Copper, wrought, of other sorts... | " | 638 | 1,023 | 14,322 | 5,568 | 3,887 | 5,784 | + 1,897 | 87,669 | 33,944 | − 53,725 |
| Brass of all sorts ... ... ... | " | 3,808 | 3,601 | 21,367 | 24,974 | 19,051 | 17,884 | − 1,167 | 114,063 | 124,109 | + 10,046 |
| Lead, Pig, Rolled, Sheet, Piping, Tubing, and Lead Shot | tons | 2,887 | 3,607 | 19,477 | 22,631 | 62,549 | 77,235 | + 14,686 | 414,112 | 488,189 | + 74,077 |
| Lead Ore, Lead, Red and White, and Litharge of Lead ... | " | 806 | 608 | 5,321 | 3,774 | 17,695 | 15,126 | − 2,569 | 117,666 | 90,328 | − 27,338 |
| Salt ... ... ... ... ... | " | 61,606 | 57,723 | 374,169 | 367,709 | 31,720 | 28,623 | − 3,097 | 183,208 | 170,955 | − 12,253 |
| Tin, unwrought ... ... ... | cwt. | 10,994 | 10,239 | 49,189 | 46,757 | 61,652 | 59,804 | − 1,848 | 287,162 | 274,842 | − 12,320 |
| Tin Plates ... ... ... ... | " | 121,283 | 122,229 | 640,445 | 667,337 | 146,102 | 144,539 | − 1,563 | 766,683 | 780,600 | + 13,917 |
| Zinc or Spelter, wrought or unwrought ... ... ... | " | 5,833 | 11,589 | 55,936 | 51,599 | 5,773 | 10,883 | + 5,110 | 55,064 | 50,747 | − 5,317 |
| | | | | | £ | 2,208,962 | 2,412,749 | + 203,787 | 12,086,278 | 13,766,639 | +1,680,461 |

# Current Notes and Memoranda.

"DIVIDEND" AND "PROGRESSIVE" MINES IN CALIFORNIA.—The *Mining and Scientific Press* of San Francisco, California, publishes a list of 254 mining companies having offices in that city, classified into "dividend" and "progressive" mines. Out of this number only *four* are entered as "dividend" mines, the other 250 being put down as "progressive." This is certainly a most extraordinary disproportion, far exceeding as it does the relative numbers given in the *Mining Journal* list. So it seems that the luxury of "progressive" mines is not confined, as some supposed, to old countries possessed of a plethora of accumulated capital; but that they are to be found in still greater numbers in one of the youngest of our transatlantic communities.

ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the last monthly meeting of this association, Mr. Fletcher presented his report, from which it seems that 313 engines and 401 boilers had been examined during the month. Out of these boilers five were found to be fractured, one dangerously so; fourteen in a state of corrosion; seven safety valves out of order; three furnaces had over pressure; and one dangerously deficient in water. Nine explosions occurred during the month, from which five persons were killed and three injured. None of these boilers were under the inspection of the association. In one case the explosion was entirely due to the delapidated condition of the boiler, which competent inspection could not have failed to have discovered. Mr. Fletcher concluded with some suggestions as to the best mode of setting boilers.

THE HARTLEY COLLIERY RELIEF FUND.—The executive committee report that out of the total amount subscribed to this fund, 83,234*l*. 17*s*. 9*d*., after providing for every claim likely to be made, there remains a surplus of 20,440*l*. This, with the sanction of the subscribers, they propose handing over in certain proportions to a local committee, to be appointed in each of the twelve districts of inspection in England and Scotland, to be applied to the relief of suffering occasioned by colliery accidents.

TREATING GAS OBTAINED FROM COAL AND MINERAL OILS.—Mr. J. Leigh proposes to subject the gas obtained in the distillation of coal, cannel, bituminous shale, boghead minerals, oils, petroleum, or other combustible substances to the action of nitric acid, or of a mixture of nitric and sulphuric acids, by which nitro-benzole and other compounds are obtained, and certain substances removed from the gas employed. For this purpose there is introduced into a series of earthenware vessels arranged in the form of Woulfe's bottles, a quantity of fuming nitric acid, or a mixture of nitric and sulphuric acids, and through this is passed a current of gas produced from any of the substances named, continuing the operation so long as any action is exerted by the acids upon the gas. When the operation is completed, the nitro-benzole is removed, and other products separating themselves from the acid liquid; this may be employed for purposes where weak nitric acid or a mixture of it and oxalic acids are required. This process may be used for the formation of the products of the action of the gases upon the acids alone, but where the purification of the gases is desired for the purposes of illumination it is preferred to use fuming nitric acid alone, which removes from the gases certain constituents that render them more liable to give off smoke in their combustion, whereby the odour of the gas is improved. In the process a quantity of acid vapour is mechanically carried forward with the gas, and this may be brought into contact with alkalies or mineral salts capable of removing it from the gases. Where a mixture of nitric acid and of rectified sulphuric acid is employed it is preferred to use one part of

nitric to two parts of sulphuric acid, and when fuming nitric acid is used the strongest is preferred.

An Adaptation of Siemen's Furnaces.—M. Hypolite Desmarest proposes a novel adaptation of Siemen's furnace which consists in applying it to double furnaces, or furnaces in which are two chambers for containing materials while subjected to heat in such manner that chemical, metallurgical, or other manufacturing processes in which there are two consecutive stages of operations, especially when requiring different temperatures, may be performed in the same apparatus by the reversing of the currents of heat. There are usually four regenerators with small openings; two receive and collect the heat of the products of combustion on their way to the chimney, the third receives and heats the combustible gases, and the fourth acts in like manner on the air that supports combustion. When the furnace is at work the gases and air travel separately, each through a regenerator which heats them, and then combine and evolve a high temperature, the products of combustion passing into two other regenerators, where they part with a large portion of their heat. When the two first regenerators are sufficiently cooled, and the two last sufficiently hot, the position of the valves is reversed, and the currents are also reversed in consequence; the two last regenerators then heat the entering air and gaseous currents, while the two first become heated by the passage of the products of combustion. This adaptation is applicable to furnaces for puddling or refining iron, melting copper, and other manufacturing processes in which there are two stages. When it is applied to puddling or refining iron, where the process requires different degrees of heat, there is a passage for water to circulate behind the sides, and another for cold air to circulate beneath the sole; the two combined furnaces communicate each with two regenerators, and generally have an opening between them for drawing off the slags which run over the fire-bridges. The valves work in frames, with four openings disposed diagonally, so that the regenerators may be put into alternate communication with the currents, and there are also passages under the arch for the hot gases to pass from one regenerator, and for the air to pass from the other. The products of combustion are directed to the chimney by the position of the valves.

The Extraction of Iron and Steel from Cinders.—In a letter to the *United States' Railroad and Mining Register*, Mr. Fleury, of Philadelphia, states that his attention has been occupied for some years past with the subject of utilising the cinders drawn from puddling and reheating furnaces, which are thrown away as useless by most of the rolling mills, or at most are only used as admixtures with iron ores in order to increase the yield, although it does not improve the quality of the iron. He has also made numerous experiments on a practical scale, from which he finds that these cinders contain invariably from 25 to 50 $^{0}/_{0}$ of metallic iron, combined with sulphur, silica, lime, and alumina, and forming a brittle compound of such a peculiar constitution as to defy the most ingenious efforts of the ironmasters. Mr. Fleury states that after many unsuccessful attempts, he has finally succeeded in extracting good casts, as well as wrought iron, and even good quality cast steel from this refuse material. In arriving at this result, the two great difficulties to be overcome were, first, that the oxides and metallic iron in these cinders are combined with silica and other substances in such a peculiar way, that a sufficient quantity of iron to make it pay cannot be extracted by remelting them in a puddling or cupola furnace: and secondly, that on reworking the cinders with lime alone, or with lime mixed with charcoal and clay, the product was invariably redshort, often red- and cold-short. The sulphur, silicon and phosphorus still remained combined with the iron, and the only means of obtaining good iron from these cinders was by destroying this tenacious chemical combination before placing them in the furnace. As unslacked burnt lime has

the property of decomposing silicates during the act of hydration or slacking, Mr. Fleury took advantage of this to mix a proper percentage of powdered burnt lime with fine ground cinder, and, after wetting it with water, exposed the mixture to the drying influence of the atmosphere. When dry, this compound was heated in a common puddling furnace, and treated like pig-iron, the result being that 50 °/₀ of wrought iron was obtained, which, however, still retained some traces of sulphur, leaving the iron rather red-short; and to extract this sulphur a small percentage of chlorine salts was dissolved in the water used for slacking the lime. Mr. Fleury concludes, by stating that this process is also applicable to the heating of silicious ores in the puddling, cupola, or blast-furnace, as also in Bessemer's, Neystrom's, Swett's, and other similar furnaces. The preparation of the cinder and the cost of the lime, salt, &c., does not exceed $2 per ton, and, if properly worked, the result is invariably a good quality iron.

Manufacture of Iron and Steel.—Mr. H. Bessemer, in his patent for improvements in the manufacture and treatment of malleable iron and steel, and in apparatus employed in it (specif. 114), proposes (as far as regards the first part of the invention) to use, for very large charges of metal, a fixed vessel, consisting of a vertical cylinder, having a flat bottom and domed top, and terminating in an inclined opening; below the converting chamber is formed a shallow receiver with an inclined bottom, terminating in a spout. The flat bottom of the converting vessel consists of an iron frame, with numerous conical holes, into which twyers are fitted; on the top of each twyer a cap of fire-clay is placed, and the spaces left between the twyers are filled up with ground ganister level with the top of the twyer caps; the blast pipe communicates with the chamber below the twyers. The spout being closed during the blowing operation before the air is turned on, the whole of the charge of fluid iron may be run in through an opening made in the side of the vessel, which is then stopped with loam, and the valve on the blast pipe being opened, the air will fill the receiver and pass upward through the metal, thus clearly defining the time of commencing the process, which may be as suddenly arrested by the simultaneous shutting of the air-pipe and opening the spout of the receiver when the metal will rapidly descend through the twyer holes into the receiver. The second part of the invention relates to a converting vessel made with a moveable bottom, the lining of the vessel being supported during the removal of the bottom by a ring of iron bolted to a stout hoop rivetted around the lower part of the vessel; the twyer box is bolted to the moveable bottom, and is provided with three wheels by which it is wheeled away in conjunction with the bottom of the vessel, and is replaced by another bottom of the same construction. The patent also refers to certain modifications of the furnaces employed in the manufacture of malleable iron and steel; and to a mode of treating ingots and masses of cast malleable iron or steel, and preparing them for the manufacture of plates or sheets by the process of rolling.

Geological Survey.—The Geological Survey made considerable progress during the last year; 2,430 square miles were surveyed in Great Britain; the publication of the maps proceeded, and memoirs were issued illustrating the geology of the Isle of Wight and the country round Bolton-le-Moors. In Ireland the new ground examined amounted to about 1,028 square miles; four new numbers explanatory of the maps were issued. The surveyors were also engaged on the re-examination of the districts of of igneous rocks running from Wicklow into Waterford.

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We have to draw attention to the death of Mr. Samuel Baldwyn Rogers, which took place at Newport, Monmouthshire, on Sept. 5th. Mr. Rogers'

name will be remembered in connection with a variety of inventions in metallurgical processes, particularly in the working of blast-furnaces.

Want of space compels us to postpone the conclusion of Herr Thum's note on Lead Smelting in Carinthia, and M. Moissenet's Memoir on the Cornish Methods of drawing Stuff.

## Patents relating to Mining and Metallurgy.

*(Compiled from Commissioners of Patents' Journal.—Subject matter only given).*

### Application for Patents from July 25th to Sept. 18th.

1857 (1863). P. E. Gay, Improvements in boring apparatus.

1860 (1863). C. Crockford, Improvements in treatment of certain waste products from manufacture of alkali.

1872 (1863). A. A. A. de Rostaing, Manufacture of iron and steel with cast-iron in a divided state.

1888 (1863). W. and S. Firth, Improvements in machinery for working coal and other mines.

1908 (1863). R. E. Bibby, Improved fireproof cement, for fire-bricks, crucibles, retorts, and melting-pots.

1946 (1863). J. Kirkham, Improved apparatus for generating heat for smelting and other purposes.

1954 (1863). R. A. Brooman, Improvements in coke ovens.

1980 (1863). A. V. Newton (com. from T. Allin), Process for hardening cast-iron.

1981 (1863). J. G. Willans, Improvements in the manufacture of iron.

1987 (1863). R. Mushet, Improvements in the manufacture of cast steel.

2012 (1863). E. B. Wilson, Improvements in blast-furnaces.

2080 (1863). R. Griffiths, Retorts for extracting oil from bituminous substances.

2086 (1863). R .A. Brooman (com. from H. Micolon), A new metallic alloy.

2110 (1863). W. E. Newton (com. from M. Colson), Apparatus for extracting coal and ores from mines.

2122 (1863). G. Davies (com. from A. L. Fleury), Manufacture of iron and steel from cinders of puddling furnaces.

2125 (1863). E. Vickers, Improvements in the manufacture of steel.

2185 (1863). J. Hendry and W. Coutts, Improvements in furnaces.

2203 (1863). L. Mond, Obtaining sulphur and sulphurous acid from alkali waste.

2245 (1863). M. Gerstenhofer, Construction of furnace for roasting pyrites.

2255 (1863). T. Bell, Distillation of bituminous minerals.

2256 (1863). W. E. Gedge (com. from F. Chapuis and L. Decombette), Miners' safety lamps.

2277 (1863). J. McEwen, Coke and hot blast apparatus.

2293 (1863). G. Davies (com. from W. Gerhardt), Manufacture of iron and steel.

### Notices to Proceed from April 2nd to July 25th.

849 (1863). J. Cassell, Distillation of petroleum oil.

802 (1863). W. M. Morgan, Improvements in coating metals.

846 (1863). J. W. Law and J. Inglis, Improvements in moulds for casting.

853 (1863). A. P. Price, Fusion, manufacture, and refining of metals.

1242 (1863). H. Bennett, Apparatus for puddling iron.

884 (1863). J. Mosheimer, Machinery for crushing, grinding, and dressing ores.

891 (1863). A. Kinder, Coating lead or its alloys with tin or its alloys.

920 (1863). W. CLARK (com. from L. N. LANGLOIS), Improvements in separating ores from their gangues.
972 (1863). C. W. and F. SIEMENS, Improvements in smelting-furnaces.
1053 (1863). F. BENNETT, Condensing lead fumes from furnaces.
1954 (1863). R. A. BROOMAN (com. from C. C. P. N. PERNOLET), Improvements in coke ovens.
1072 (1863). G. E. DONISTHORPE, Apparatus for getting coal.
1613 (1863). R. MUSHET, Improvements in manufacture of iron and steel.
1980 (1863). A. V. NEWTON (com. from T. ALLIN), Process for hardening cast-iron.
1115 (1863). J. H. JOHNSON (com. from A. MUELLER), Manufacture of wrought iron and steel.
1420 (1863). J. G. JONES and R. RIDLEY, Apparatus for working coal mines.
1857 (1863). P. E. GAY, Improvements in boring apparatus.

PATENTS SEALED FROM JULY 31ST TO SEPT. 18TH.

385 (1863). G. H. BIRKBECK (com. from C. ROSWAG), Separating silver or other metals from lead.
1456 (1863). J. WEBSTER, Indurating iron, and in protecting iron and steel from oxidation.
388 (1863). J. JONES, The amalgamation of lead, tin and other metals of like nature into sheets, and coating lead &c. with tin.
708 (1863). W. E. NEWTON (com. from E. G. BOIGNES and P. RAMBOURG), Improvements in the mannfacture of iron and steel.
903 (1863). G. LOW, Improved machinery for boring rocks.
534 (1863). G. TOMKINS, Manufacture of tin and terne plates.
560 (1863). V. D. DELAHAYE, Apparatus for excavating coal.
646 (1863). R. MUSHET, Manufacture of pig or cast iron.
1513 (1863). W. H. DAWES, Improvements in the manufacture of iron.
788 (1863). R. MUSHET, Treating steel and iron prepared by the pneumatic process.
1602 (1863). R. MUSHET, Improvements in the manufacture of iron and steel.
679 (1863). J. POLKINGHORNE, Apparatus for treating tin ores and matters containing alkali.
818 (1863). R. MUSHET, Moulds for casting steel.

PATENTS ON WHICH £50 DUTY HAS BEEN PAID, FROM AUG. 25TH TO SEPT. 14TH.

2131 (1860). J. HUGHES, W. WILLIAMS, and G. LEYSHON, Manufacture of tin and terne plates.
2233 (1860). R. MUSHET, Manufacture of cast steel.
2207 (1860). J. WRIGHT (com. from L. LERMUSIAUX), Davy lamps.
2298 (1860). R. MUSHET, New or improved metallic alloy.
2365 (1860). R. MUSHET, Manufacture of cast steel.
2257 (1860). G. F. SMITH (com. from R. W. SIEVIER), Smelting iron and other ores.

PATENTS ON WHICH £100 DUTY HAS BEEN PAID, FROM JULY 22ND TO JULY 27TH.

1742 (1856). J. ONIONS, Improvements in the manufacture of iron.
1793 (1856). J. KNOWLES and W. BUXTON, Improvements in twyers.

PATENTS BECOME VOID BY NON-PAYMENT OF DUTY, FROM JULY 25TH TO SEPT 12TH.

1748 (1860). J. H. JOHNSON (com. from G. A. OZOUF), Manufacture of white lead.
1759 (1860). J. BROAD, Apparatus for economising fuel in smelting.
1759 (1856). G. A. COPELAND, Safety blasting cartridge.
1904 (1860). J. BONNE, Improvements in furnaces for working iron.
2105 (1860). J. H. JOHNSON (com. from A. MUELLER and A. LENCAUCHEZ), Treatment of zinc ores.
2111 (1860). J. G. WILLANS, Manufacture of iron and steel.

2165 (1860). C. Cowper (com. from L. J. Dubesme, and H. de Ruolz and A. L. de Fontenay), Manufacture of cast steel.

2095 (1856). W. Petrie, Manufacture of sulphuric acid.

2115 (1856). S. White, Distillation of petroleum.

## AUSTRIA.

### Patents delivered from May 4th to June 25th.

242 (1863). E. W. Siemens and J. G. Halske, A regenerating gas and coke kiln.

299 (1863). C. Kasper (com. from Mueller & Co.), Manufacture of zinc.

311 (1863). C. Kasper (com. from Mueller & Co.), Manufacture of iron and steel.

## BELGIUM.

### Patents delivered from July 1st to September 15th.

14,622 (1863). A. Crooy (com. from X. F. Girard), Tinning, leading and zinking metals.

14,663 (1863). A. Calvet (com. from C. Jean), Preparation of coal dust.

14,688 (1863). H. Biebuyck (com. from W. F. Street), Treatment of petroleum.

14,697 (1863). C. Laroche, Conglomerating small coal.

14,704 (1863). C. Rockaert (com. from H. Holcroft), Apparatus for washing and separating ores.

14,708 (1863). C. Rockaert (com. from M. Mennons), Manufacture of metallic zinc.

14,745 (1863). A. Calvet (com. from A. A. A. de Rostaing), Manufacture of iron and steel from pig-iron in a separate state.

14,811 (1863). H. Biebuyck (com. from T. Allin), Process for hardening cast-iron.

14,823 (1863). J. Gerard and J. B. Baillet, Puddling, reheating and reverberatory furnace.

14,849 (1863). G. Neuhaus (com. from R. Daelen and Fleitmann), Smelting furnace with crucibles.

14,873 (1863). N. J. D'Or, Gas furnaces for reducing zinc ores.

14,946 (1863). D. Herode (com. from E. B. Wilson) Improvements in blast-furnaces.

14,958 (1863). H. Biebuyck (com. from A. L. Fleury), Manufacture of iron and steel.

## FRANCE.

### Current List of Patents.

52,705 (1862). De Lapparent, Carbonising wood by gas.

52,510 (1862). Laurent Bros., Malleable pig-iron.

56,965 (1863). Terver and Bohin, Tempering pig-iron.

56,997 (1863). Sudre, Purifying and collecting cast steel obtained without crucibles.

57,174 (1863). Cochut, Metallurgic treatment of silver.

57,448 (1863). Dreyfous (com. from Nicquet), Apparatus for washing and separating ores.

57,480 (1863). Bresson (com. from Ram), Furnaces for roasting pyrites.

57,521 (1863). Flachat (com. from Boignes, Rambourg and Co.), Manufacture of iron and steel.

## SAXONY.

### Patents delivered from April 1st to June 30th.

29 (1863). Böhme (com. from Mueller & Co.), Improvements in obtaining zinc.

36 (1863). BÖHME (com. from MUELLER & Co.), Manufacture of cast-iron forge iron, and steel.

## SPAIN.

### PATENTS DELIVERED DURING 1862.

6. F. BENNELT, Manufacture of zinc.
11. J. B. DE LA PENNA, Treatment of copper ores.
13. F. W. DACHNE, Treatment of copper ores.
20. J. L. DALIFOL, Manufacture of malleable cast-iron.
40. MUELLER & Co., Treatment of zinc.
57. SANTANDER MINING AND SMELTING Co., Reduction of zinc ores.
63. H. MACMEIKAN, Smelting copper, gold, and other ores.
78. B. MARIN and C. ROUVAG, Working lead by means of zinc.
131. J. C. SCHEMMANN, Manufacture of Steel.
132. J. L. DALIFOL, Manufacture of malleable pig-iron.
141. C. E. A. VATIER and A. J. G. BECOURT, Extracting silver from ores.

## UNITED STATES.

### PATENTS ISSUED FROM JULY 14TH TO AUGUST 11TH.

39,257 (1863). J. L. CONSTABLE, Improvement in refining ores.
39,364 (1863). E. B. WILSON, Manufacture of malleable iron and steel.
39,372 (1863). R. BARCKLEY, Improvement in cupola furnaces.
39,531 (1863). R. SAVARY and R. C. TOTTEN, Uniting iron and steel with copper and brass.

### SPECIFICATIONS PUBLISHED FROM JULY 18TH TO SEPT. 19TH, AND PRICES.

3353 (1862). J. McINNES and E. F. PRENTISS, Distilling and treating petroleum, &c.; 1*s.*
3375 (1862). F. DE WYLDE (com. from H. SCHWARZ), Preservation of lead surfaces; 8*d.*
3384 (1862). J. CLAYTON, Reverberatory furnaces; 1*s.* 4*d.*
3412 (1862). J. McLEAN, Obtaining oil from shale, &c.; 4*d.*
3426 (1862). E. B. WILSON, Manufacture of malleable iron and steel; 4*d.*
3438 (1862). W. HENDERSON, Obtaining iron and steel from ores and residual products; 6*d.*
3475 (1862). W. and H. BOWSER, Coating iron or steel; 8*d.*
48 (1863). E. V. GARDNER, Treating petroleum, &c.; 1*s.*
84 (1863). M. HENRY (com. from G. DESMAREST), Furnaces; 6*d.*
114 (1863). H. BESSEMER, Manufacture of iron and steel; 2*s.* 10*d.*
247 (1863). E. F. PRENTISS and J. C. SELLARS, Treating mineral oils; 4*d.*
342 (1863). J. CAMERON, Manufacture of iron; 4*d.*
355 (1863). H. G. WILLIAMS and R. G. PRICE, Machine for crushing quartz; 4*d.*

# Trade Review of Mining, Quarrying, and Metallurgy.

## WESTERN COUNTIES.

Dullness continues to be the prevailing characteristic of mining in Cornwall, although perhaps not to quite the same extent as last month. The tin standard has been again reduced, and the copper standard, which has been advancing for so long, has declined altogether upwards of 3*l.*

One of the most successful meetings of the Royal Cornwall Polytechnic Society commenced at Falmouth, on Sept. 15th. The mechanical department showed a decided improvement on last year, and among the articles exhibited bearing on our subject may be mentioned :—some lead specimens, forwarded by Mr. Baker, of Sheffield ; a continually discharging percussion table for slime dressing ; a direct acting steam stamps ; a model of a mine capstan ; and a crusher for tin ores. Mr. Pengelly, F.R.S., F.G.S., delivered an interesting lecture on the Antiquity of Man.

At *Tywarnhaile* they are said to have a good discovery at the 75. At *Clifford Amalgamated* they are reported to have a serious run of ground, and it is said that some time must elapse before the usual operations can be carried on. At *Nanjiles* the lode in the engine shaft is said to be worth 30*l.* per fm., and the 86 fm. level, east of Bread and Cheese shaft, is also reported to be improved.

At *Wheal Hearle* meeting (on Aug. 27th), it was resolved that a committee be appointed to examine the accounts under the direction of Mr. T. Hollow, the executor of the late purser, and to ascertain the actual position of the company; also empowering them to employ any competent mining agent to inspect the property, with the view of determining the amount that would be required for its efficient working during the next twelve months. At the adjourned meeting (on Sept. 24th), it was resolved to subdivide the mine into 4,096 shares. At *Grambler and St. Aubyn* meeting (on Sept. 8th), votes of thanks were passed to the Duke of Buckingham and Mr. Trelawny for remitting the dues during pleasure. At *Rosewarne United* meeting (on Sept. 21st), it was proposed to have the general meeting alternately in London and Cornwall, but this was strongly opposed and defeated by a small majority.

The new concerns announced during the month are :—the *Tredinney Mining Company*, with a capital of 20,000*l.*, in shares of 5*l.* each, formed for the purpose of developing the sett of the same name in the parish of St. Just. The purchase money is to be 4,000*l.*, half in cash, and half in shares. The *Clowance Wood Copper Mining Company*, with a capital of 25,000*l.*, in shares of 1*l.* each, propose working a sett in the parish of Crowan. The purchase money to be 5,000*l.*, of which 1,500*l.* is to be paid in cash, and the remainder in paid-up shares. The *New Rosewarne* mine is to be worked on the cost-book system in 1,024 shares. The sett formed, until recently, the western part of *Rosewarne United Mines*. A prospectus has been issued of the *East Botallack Mining Company* (limited), with a capital of 18,000*l.*, in shares of 3*l.* The purchase-money to be 4,500*l.*, of which 2,000*l.* is to be in paid-up shares, and the remainder in cash. *Chiverton Wheal Rose Silver-Lead* mine is to be worked by a cost-book company in 100 shares. *Cleers Hill Tin Mine* is also to be worked by a cost-book company, composed almost entirely of local adventurers. It is reported that *Penhallow Moors*, adjoining East Wheal Rose, is to be worked, the number of shares to be 512.

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## WALES AND THE BORDERS.

South Wales.—The iron trade has decidedly improved, and it is hoped that more business will be transacted this winter than has been the case for the last two years. The export trade continues active, and large consignments have been made to America, and to Italy and other European states. The puddlers, encouraged by the strike in South Staffordshire, have demanded higher wages, which the masters do not seem unwilling to grant. The ironmasters have been well supplied with orders, and at some of the works more hands could have been employed. Merchant bars have been quoted at from 6*l.* 5*s.* to 6*l.* 7*s.* 6*d.*, and no orders booked lower.

Emigration still goes on with great activity, and if it continues much longer, will, it is feared, cause serious inconvenience to the masters.

The Plymouth ironworks have, it is said, passed into the hands of Mr. R. Fothergill of Aberdare, and Mr. T. S. Hankey, the banker.

The coal trade has also been more active, and prices generally close firmer. The colliers of this district have been induced by those of South Staffordshire to ask for higher wages. It is doubtful whether they will obtain them, but in any case a strike is not probable. It is stated that a fine colliery is being opened up at Abercarn by the Ebbwvale Company.

The iron ore and coal mines of Llanharry, lately the property of the *Llanharry Hematite Iron Ore Company* (Limited), and now belonging to Mr. J. Bethell, are likely, it is said, to become very valuable. A colliery explosion occurred on Sept. 21 at Abernant, by which one workman was killed and several others seriously injured.

The returns from Cardiff show that during the month of August 418 ships cleared the port, and the exports were 131,122 tons of coal, 14,442 tons of iron, and 293 tons of coke. For the eight months of the year 930,564 tons of coal, and 126,392 tons of iron were exported, against 871,524 tons of coal and 129,088 tons of iron in the corresponding period of 1862, and 736,328 tons of coal and 95,247 tons of iron in 1861.

An abstract of the trade of Neath (including the Briton Ferry Docks) for August shows that the number of ships entering the harbour was 251, with a register tonnage of 19,335, the burden tonnage being 29,504. The imports were 3,409 tons of copper ore ; 1,110 tons of pig-iron ; and 4,590 tons of iron ore. The exports were 25,098 tons of coal, coke, and culm ; and 281 tons of tin plates, being altogether a decrease compared with the corresponding month of 1862.

The statistical returns of the trade of Swansea during August show a falling off in the number of vessels entering the port, compared with the corresponding month of last year. The number entering last month was 485, with an aggregate registered tonnage of 54,162 tons ; and the shipping rates received were 1,371*l.* 15*s.* 2*d.*. During the corresponding month last year the number of vessels was 549, with an aggregate registered tonnage of 55,656, and the shipping rates were 1,346*l.* 16*d.* 2*d.* The European and foreign trade of last month exceeded that of the same period last year. The arrivals during the month include:—silver ore from Alicante, copper ore from Cobiga, Cherbourg, Pan des Azucar, and South Australia; and iron ore from Cherbourg.

GLOUCESTERSHIRE.—Among the imports into Bristol during the month have been :—600 tons of sulphur ore from Pomaron, and 859 tons from Arklow ; 40 tons of silver lead ore from Teignmouth, 220 tons of iron from Cardiff ; 120 tons of tin plates from Newport ; 5 tons of pig-iron, and 27 casks of lead ore from Liverpool ; 30 tons of silver ore from Aberystwith ; 270 tons of pig-iron from Glasgow and Belfast ; 10½ tons of tin from Truro ; and 19 casks of yellow metal and 500 slabs of tin from Rotterdam. The exports include :—418 tons of coals. During the month of August, 295 tons of coal and 3,236 tons of iron were exported over sea from Bristol, against 766 tons of coal, and 1,284 tons of iron, in the preceding month, showing a *decrease* of 471 tons of coal, but an *increase* of 1,952 tons of iron. With regard to the general trade of the port, we find that the customs' duties during the month amounted to 106,979*l.* 12*s.*, and that in the same period 119 vessels entered from foreign ports with cargoes, and 13 vessels cleared outwards with cargoes.

The imports into Gloucester comprised :—870 tons of sulphur ore from Pomaron ; 50 tons of iron from Swansea ; 50 tons from Briton Ferry ; and 110 tons of coal from Saundersfoot, with 35 tons from Landshipping. The exports include :—554 tons of iron, and 119 tons of coal.

NORTH WALES.—The *Peel* (Isle of Man) *Slate Quarry* is, it is said,

about to be worked by a limited company, with a capital of 20,000*l.*, in shares of 5*l.* each.

The *East Pant Du United Lead Mining Company* (limited) has issued a prospectus. The capital is to be 30,000*l.*, in shares of 5*l.* each. The setts proposed to be worked are the East Pant Du, the Pant Du, and the Colomindy setts.

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## MIDLAND COUNTIES.

Staffordshire and Warwickshire.—Business generally was very unsettled at the beginning of the month, owing chiefly to the constant demand for higher wages, and the ironmasters were so much pressed with orders that they declined taking more, even at an advanced price; on the whole, however, there has been a fair amount of activity.

The preliminary meeting of the ironmasters of South Staffordshire and East Worcestershire was held at Birmingham, on Sept. 24th. The attendance was large, the proceedings exciting an unusual amount of interest in consequence of the anomalous position in which the trade has been placed since the advance of 10*s.* per ton in the price of finished iron, as determined at Wolverhampton a few weeks ago. At the time that advance was made the wages scale of the puddlers and millmen was raised 1*s.* per ton, thus giving them an unfair advantage, and, moreover, departing from a long established usage in the trade which has given to this class of the workmen a rise or fall of 1*s.* per ton per pound sterling in the price of iron. It was felt that the decision at Wolverhampton was a mistake in that respect, and soon after the meeting had been held, circulars were issued by several firms, announcing that future orders would only be taken at a further advance of 10*s.* per ton; and in the course of the last ten days there has been a feeling in favour of a rise of 1*l.* per ton, orders being only accepted subject to the price to be fixed to-day. At the meeting to-day a lengthened discussion took place; many members of the trade intimated that they were full of orders, and that an advance of 10*s.* would not enable them to cope with fresh difficulties which might be expected to arise with the men. Ultimately it was resolved that the price of bar iron be advanced 1*l.* per ton, making it 8*l.* 10*s.*; other descriptions of finished iron to be raised in proportion.

It was further resolved to raise the puddler's wages 1*s.* per ton, the wages of the millmen to be advanced to the same rate as when puddling was 9*s.* 6*d.* per ton.

Ironstone has been in good request, as also whitestone and gubbin.

There has been a good demand for coal, and the consumption has been sufficiently large to maintain activity in all the collieries. Some of the thin coal colliers are reported to be dissatisfied because their wages were only advanced 10 per cent. instead of 20 per cent.

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## NORTHERN COUNTIES.

Northumberland and Durham.—The coal trade, which at the beginning of the month was rather dull, has since improved, and nearly all the Northumberland steam coal companies have lately been working full time. The iron trade has had an upward tendency, particularly that of Cleveland, and prices have advanced; for the Cleveland pig-iron, although some years ago considered unfit for smelting, is now largely consumed for purposes where great strength is required.

Messrs. Kennedy Brothers are reported to have lately discovered another valuable vein of hematite iron ore on the Greenscow estate.

On Tuesday, Sept. 1st, an accident occurred at Burroden Colliery, but no lives were lost, and it was expected the machinery would not take long to put in working order. An accident also took place at Auckland Park Colliery, on Sept. 12th, by which four lives were lost.

On Sept. 1st, the district of South Durham and Cleveland contained sixty-three furnaces in blast, and only seventeen out of blast, of which latter thirteen belonged to the Consett establishment. Compared with the corresponding period of last year, this is an increase of fifteen furnaces in blast, and an addition of four to the total number. The details are as follows:—

| Place and Owners. | In. | Out. | Total. |
|---|---|---|---|
| Eston — Bolckow and Vaughan .. .. .. | 9 | — | 9 |
| „ Clay Lane Company .. .. .. | 3 | — | 3 |
| „ South Bank Company .. .. .. | 3 | — | 3 |
| Cargo Fleet—Jones, Dunning and Co. .. .. | 2 | — | 2 |
| „ Cochrane and Company .. .. | 4 | — | 4 |
| „ Gilkes, Wilson, Pease and Co. .. | 4 | 1 | 5 |
| Middlesborough—Bolckow and Vaughan .. .. | 3 | — | 3 |
| „ Hopkins and Co. .. .. | 2 | 0 | 2 |
| Port Clarence—Bell Brothers .. .. .. | 5 | 1 | 6 |
| Norton—Warner, Lucas and Barrett .. .. | 3 | — | 3 |
| Ferry Hill—J. Morrison .. .. .. .. | 3 | — | 3 |
| Stockton—Holdsworth and Co. .. .. .. | 3 | — | 3 |
| Thornaby—W. Whitwell and Co. .. .. .. | 3 | — | 3 |
| Darlington—South Durham Company .. .. | 3 | — | 3 |
| Whitton Park—Bolckow and Vaughan .. .. | 4 | — | 4 |
| Stanhope—Weardale Iron Company .. .. | — | 1 | 1 |
| Towlaw—Weardale Iron Company .. .. .. | 4 | 1 | 5 |
| Consett—Derwent Iron Company .. .. .. | 5 | 13 | 18 |
| Total .. .. .. .. | 63 | 17 | 80 |
| All places, Sept. 1st, 1858 .. .. .. .. | 51 | 14 | 65 |
| „ „ 1859 .. .. .. .. | 52 | 15 | 67 |
| „ „ 1860 .. .. .. .. | 52 | 22 | 74 |
| „ „ 1861 .. .. .. .. | 48 | 28 | 76 |

Among the imports into the Tyne during the month were :—cargoes of pyrites from Huelva, Sevanger, Cadiz, Antwerp, Drontheim, Pomaron, and Dordt ; a cargo of manganese from Huelva ; 840 pigs of lead from Seville ; 4,150 bars of lead from Carthagena ; and 1.408 bars of iron from Gothenburg.

YORKSHIRE.—The coal trade has much improved during the past month, and the inquiry for house coal in particular has been very brisk.

An inquest was held at Barnsley on the bodies of some of the men killed in the Edmund's Main Colliery explosion on the 8th December last. Thirty bodies have been discovered, and twenty-eight or thirty more are still missing. The inquest has been adjourned for two months, until the mine be in a fit state to allow of a thorough examination.

## SCOTLAND.

The coal trade has been inactive, and the amount of business transacted has been limited. At the borings now going on around the town of Airdrie, several new fields of coal have, it is said, been found.

There has been a fair amount of activity in the pig-iron market, with considerable fluctuations in prices. The following are the shipments for the eight months of the present year, as compared with the corresponding eight months of 1862, 1861, and 1860 :—

| Month. | 1863. | 1862. | 1861. | 1860. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| January.. .. .. .. | 30,467 | 44,729 | 39,267 | 38,625 |
| February .. .. .. | 38,867 | 39,614 | 33,070 | 26,883 |
| March .. .. .. .. | 50,909 | 44,495 | 33,474 | 39,152 |
| April .. .. .. .. | 57,345 | 63,160 | 62,622 | 50,585 |
| May .. .. .. .. | 67,820 | 70,461 | 82,036 | 66,701 |
| June .. .. .. .. | 53,806 | 42,167 | 57,201 | 40,712 |
| July .. .. .. .. | 51,181 | 41,581 | 48,304 | 47,846 |
| Week ending Aug. 1 .. .. | 11,458 | 10,135 | 11,971 | 10,949 |
| " " 8 .. .. | 14,641 | 11,447 | 10,237 | 12,871 |
| " " 15 .. .. | 10,895 | 12,847 | 10,237 | 11,761 |
| " " 22 .. .. | 8,869 | 11,341 | 11,489 | 15,883 |
| " " 29 .. .. | 13,671 | 12,255 | 10,526 | 13,752 |
| Total .. .. | 409,929 | 394,232 | 408,434 | 374,720 |

The exports already show a considerable increase on former years, and it seems probable will by the end of the year greatly exceed them.

A discovery of a valuable seam of blackband ironstone has, it is said, been made on the Shieldhall estate, which promises to be of considerable importance to the district.

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## FOREIGN AND COLONIAL.

FRANCE.—The iron trade has been more active during the past month, prices have risen and continue to show an upward tendency. The works of the Moselle district have been fully occupied, and a good business has been done. A large foundry is about to be installed at the Hayange works, and the construction of the furnaces at Longwy is being actively pushed forward.

The most crying demand of those interested in the coal and iron trades of France has long been for a greater extension of the system of internal communication—either by improving the navigation of rivers, the opening of new canals, and the extension of the railway system. In the season of 1862 the Government has made great advances in this respect. The navigation works of the Seine, the Marne, the Yonne, the Rhône, the Loire, and the Garonne have been greatly advanced; and a certain number of minor streams have been much improved.

In canals, the greatest efforts have been directed to improving those already existing, by deepening, widening, and other alterations; but the works on new canals have also been well pushed on, and some new ones have also been decided on. Railway communication has also been well pushed on to open up the various coal-fields. Two lines, important in this respect, have been conceded to the Northern Railway Company—one from

Lille to Tournai, and the other from Valenciennes to the Saint-Quentin and Erquelines line.

Belgium.—There has been a good deal of business done in the Belgian iron market, indeed the Liège works have received so many orders that to satisfy them the Dolhain furnace which has been out of blast for some time is about to be relighted.

The coast trade has been active, and large orders have been received, though operations have been rather checked from a scarcity of boats.

Italy.—The *Bellabio Lead Mines*, situated a few miles from Lecco, in Northern Italy, are, it is said, about to be worked by an English limited liability company.

United States.—The petroleum trade continues to increase largely. From New York the shipments during the present year have reached to 13,500,000 gallons, from Philadelphia 4,000,000 gallons, from Boston 1,500,000 gallons, and from Baltimore 750,000 gallons, showing a total of nearly 20,000,000 gallons in less than eight months.

Canada.—It has been reported that gold has been found in the Seignory of Vandreuil and on the tributaries of the river Chaudière, about 50 miles from Quebec.

Tasmania.—It is said that a seam of coal has been discovered, which is supposed to be very valuable, and which, there is every reason to believe, is workable.

Australia.—The following advices were brought by the Australian mail from the various mining companies. At *English and Australian* there were four furnaces and one refinery at work at Kooringa, and four furnaces and one refinery at the Port works. Since the date of the last advices a shipment of 31 tons 7 cwts. of copper has been made to India.

From *Port Phillip and Colonial* they report that the quantity of quartz crushed during the four weeks ending the 11th of July was 3,132 tons yielding 1,402 ozs. of gold, or an average of 8 dwts. 22 grs., being a considerable improvement in the quantity of ore crushed as well as an increase of 1 dwt. 2 grs. per ton in the yield.

At *Kapunda* the quantity of ore raised in May was 267 tons of 19½ °/o average produce, exclusive of 130 tons of sulphur ore for flux. The quantity raised in June is estimated at 300 tons of good quality. The sinking of the Buhl engine-shaft to the 70-fathom was being continued with rapid progress. The tributers were well employed in the working pitches, and the ores raised of better quality. At the smelting works the cessation of rain allowed the woodcutters to send large supplies of fuel. The furnaces and refinery were in thorough repair and in full work. About 50 tons of copper were made during the month, and the manager hoped that in the remaining months of the year he would be able considerably to reduce the large stock of ores on hand. A parcel of 26 tons of copper had been forwarded to Melbourne for transhipment, and 21 tons more would follow by the next steamer.

From *Worthing* they advise that the quantity of ore returned during July was 140 tons, of higher percentage than in former months. The dressing was going on much the same. An unusual quantity of rain had been much against working out of doors. The two furnaces turned out about 50 tons of good regulus during the month.

At *Great Northern* they report that a good bunch of ore has been cut, but no certain information has been received.

From *Bon Accord* they advise that they are losing no time in endeavouring to obtain the services of a properly qualified person to proceed to the mine and to make a thorough examination of it, preparatory to recommencing the sinking of the engine-shaft and the prosecution of mining operations at the depth of 60 or 70 fathoms.

# Record of the Mining and Metal Markets.

## METALLIC-ORE MARKETS.

TIN.—The standards for black tin have been again reduced 4*l.* on fine, and 3*l.* on common, and now stand at :—

| | | | | |
|---|---|---|---|---|
| Superior Fine | .. £108 | .... | Superior Common | .. £105 |
| Second Fine | .. 106 | .... | Second Common | .. 104 |

COPPER.—At the four Cornish sales we give this month, the number of tons, average produce, quantity of fine copper, average price per ton, and standard have been as follows :—

| *Date.* | *Tons.* | *Produce.* | *Fine Copper.* Tons. cwt. | *Price per ton.* | *Standard.* |
|---|---|---|---|---|---|
| Aug. 27. | .. 2,872 | .. $6\frac{5}{8}$ .. | 189 0 .... | £5 0 6 .... | £118 7 0 |
| Sept. 3. | .. 3,260 | .. $6\frac{7}{8}$ .. | 223 12 .... | 5 4 0 .... | 115 14 0 |
| „ 10. | .. 2,177 | .. $6\frac{1}{2}$ .. | 142 8 .... | 4 16 0 .... | 115 8 0 |
| „ 17. | .. 6,020 | .. $5\frac{3}{4}$ .. | 349 4 .... | 4 3 6 .... | 119 6 0 |

The copper standard has steadily declined all through the month. At the sale of the 27th it declined slightly; at that of Sept. 3rd, 2*l.* according to the *West Briton*, but according to the *Mining Journal*, only 1*l.*; at the sale of the 11th, 1*l.* 10*s.*, and at that of the 17th, 1*l.*, making in all a fall of between 3*l.* and 4*l.*

LEAD.—Comparing this month's sales with those of last, we find that prices have, on the whole, advanced.

## COAL MARKETS.

LONDON, *September 28th.*—From the returns of the Registrar of the London Coal Exchange, of the quantity of sea-borne coal, culm, and cinders, imported into London in the month of August, we learn that the total quantity was 271,463 tons, against 274,834 tons during the corresponding month of last year,—showing a *decrease* of 3,371 tons.

The following are the particulars of the 271,463 tons imported during August :—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Newcastle .. | 87,872 tons, in | 229 ships | | Scotland .. | 1,648 tons, in | 14 ships |
| Seaham .. | 22,318 „ | 91 „ | | Wales .. | 9,871 „ | 28 „ |
| Sunderland . | 85,511 „ | 209 „ | | Yorkshire .. | 2,258 „ | 23 „ |
| Middlesbro'. | 7,362 „ | 27 „ | | Small .. | 2,152 „ | 4 „ |
| Hartlepool.. | 49,718 „ | 183 „ | | Cinders .. | 3,086 „ | 24 „ |
| Blyth .. | 667 „ | 3 „ | | | | |

The quantity of coal imported by railways and canals during the month of August was 142,820 tons, against 132,380 tons during the corresponding month last year—showing an *increase* of 10,440 tons.

The total quantity of coal imported into London during the eight months of the present year, from January to August, was 3,185,356 tons, against 3,122,369 tons during the corresponding period last year—showing an *increase* of 62,987 tons.

In the London coal market an active business has been done during the month. On August 31st, the ships arrived were 46—market brisk, with an

advance of 3*d.* The prices were: Hetton Wallsend, 18*s.*; Braddyl's Wallsend, 16*s.* 9*d.*; Lambton Wallsend, 17*s.* 6*d.*; Eden Main, 16*s.*; Butes Tanfield Moor, 13*s.*; Tees Wallsend, 17*s.* 3*d.*; Steward's Wallsend, 16*s.*; South Kelloe Wallsend, 16*s.*; Hasting's Hartley, 16*s.*; West Hartley, 16*s.* On September 2nd, new ships 31, market brisk: Hartley's advanced 3*d.* On the 4th, new ships 82, market active. On the 7th, new ships 38, market brisk: house coal advanced 3*d.* On the 9th, new ships 40, house coal brisk, and again advanced 3*d.*: Hartley's scarce and risen 3*d.* On the 11th, new ships 100, market very active. On the 14th, new ships 100, market brisk. On the 16th, new ships 78, market quiet. On the 18th, new ships 43, market trifling. On the 21st, new ships 33, market firm. On the 23rd, new ships 26, an advance of 3*d.* On the 25th, new ships 54, market brisk, and another advance of 3*d.* On the 28th, new ships 44, market active. The prices were: Haswell Wallsend, 18*s.* 9*d.*; Stewart's Wallsend, 18*s.*; Russell's Hetton Wallsend, 19*s.*; Braddyll's Wallsend, 18*s.*; South Hartlepool Wallsend, 18*s.*; South Kelloe Wallsend, 17*s.* 6*d.*; Eden Main, 17*s.* 6*d.*; Davison's West Hartley, 17*s.*; West Hartley, 17*s.*; Tanfield Moor, 14*s.*; Bute's Tanfield, 14*s.*

LIVERPOOL.—From Messrs. J. and T. Platt's Coal Circular for August, we find that the quantity of coal, cannel, coke, and patent fuel shipped from Liverpool to foreign and colonial ports during the month of August was 49,205 tons, against 67,629 tons during the corresponding month of last year—showing a *decrease* of 18,424 tons. The total shipments from January to August were 348,523 tons, against 408,580 tons in the corresponding period last year—showing a *decrease* of 60,057 tons. The exports coastwise during August were 9,915 tons, against 10,316 tons during the same month last year—showing a *decrease* of 401 tons. The total exports coastwise from January to August were 60,764 tons, against 49,490 tons during the corresponding period of last year—showing an *increase* of 11,274 tons.

## SHARE MARKETS.

LONDON, *September 28th.*—A very moderate amount of business has been transacted in the London share market during the past month, and prices have fluctuated but very little.

*East Caradon* shares have been flat all through the month, but with less variation in prices than has been the case for some time past. Shares opened on the 29th at 28*l.*-28¼*l.*, being a fall of 12*s.* 6*d.* from our closing prices of last month. They remained unaltered till the 3rd, when they improved 7*s.* 6*d.*, and again on the 4th to 28½*l.*-29*l.* They continued at this until the 9th, when they rose to 29*l.*-29½*l.*, but declined again on the 10th to 28½*l.*-29*l.*, and on the 11th to 28*l.*-28½*l.* On the 12th they improved to 28¼*l.*-28¾*l.*, but again receded on the 14th to 28*l.*-28½*l.*, at which they remained pretty steady until the 17th, when they receded to 27¾*l.*-28¼*l.* On the 19th, they recovered to 28*l.*-28½*l.*, at which they remained until the end of the month, closing at 28½*l.*-29*l.* *Marke Valley* shares have slightly advanced from our last prices. They opened on the 29th at 6*l.*-6¼*l.*, and rose on the 1st to 6⅛*l.*-6⅝*l.*, and also on the 2nd to 6¼*l.*-6½*l.*, at which price they remained until the 9th, when they advanced to 6¾*l.*-7*l.*, but fell again gradually until the 17th, when they were quoted at 6¼*l.*-6½*l.*, at which they close. *Gonamena* shares have also slightly advanced. They opened on the 29th at 2¼*l.*-2¾*l.*, and advanced gradually until the 4th, when they reached their highest price of 3½*l.*-4*l.*, at which they were inquired for. They remained at this until the 7th, when they began to recede, and on the 10th had declined to 2¾*l.*-3¼*l.* On the 12th, however, they were in demand and improved to 3*l.*-3½*l.*, but fell again, closing at 2¾*l.*-3*l.* *Glasgow Caradon*

*Consols* at one time advanced to 4*l*.-4¼*l*., but receded again closing at 3¾*l*.-4*l*. *West Caradon*, 21*l*.-23*l*. *South Caradon*, 415*l*.-425*l*. *Caradon United*, 1¾*l*.-2*l*. *South Caradon Wheal Hooper*, 14*s*.-16*s*. *Caradon Consols*, 12*l*.-13*l*. *Caradon Vale*, 3¼*l*.-3¾*l*.

*East Russell* shares opened on the 29th at 3½*l*.-3¾*l*., and advanced gradually up to the 8th, when they were at their highest price of 3⅞*l*.-4⅛*l*. They receded again, however, and close the same as last month, 3⅜*l*.-3⅝*l*. *Drakewalls* shares have slightly advanced during the month from 1½*l*.-1¾*l*. to 1¾*l*.-2*l*., which is an improvement of 5*s*. upon last month. *Wheal Crebor*, 1½*l*.-1⅝*l*. *Devon Great Consols*, 555*l*.-565*l*. *Kelly Bray*, 15*s*.-17*s*. 6*d*. *New Martha*, 2½*l*.-3*l*. *Hingston Down*, 2¼*l*.-2½*l*. *Wheal Edward*, 2¾*l*.-3*l*.

There has been a fair amount of business done in *West Chiverton* shares, which have advanced altogether 12*l*. They opened 30*l*.-31*l*., and by the 7th rose to 31*l*.-33*l*. They remained steady at this until the 18th, when they were 33*l*.-34*l*., since which they have steadily advanced, closing at 45*l*.-47*l*. *Wheal Ludcott and Wrey* shares have declined slightly from last month's closing quotations. They opened 3¼*l*.-3½*l*., and fell on the 7th to 3⅛*l*.-3⅜*l*., on the 14th to 2⅞*l*.-3⅛*l*., and again on the 26th to 2½*l*.-3*l*., at which they close.

*Wheal Mary Ann* shares have receded 4*l*. per share during the month. They opened on the 29th at 12*l*.-13*l*., and continued at that with little variation until the 25th, when they fell to their closing price of 8½*l*.-9*l*. *Wheal Trelawny* shares have also risen from 16*l*.-17*l*. to 17*l*.-17¼*l*. *Chiverton* shares have advanced from 7*l*.-7¼*l*. to 8¾*l*.-9*l*. *East Chiverton*, 5*l*.-5½*l*. *Herodsfoot*, 36*l*.-38*l*. *Wheal Hope*, 2½*l*.-3*l*.

*Wheal Margaret* shares have declined 3*l*. on our last prices. They opened on the 29th at 29*l*.-30*l*., and remained at that until the 22nd, when they fell 2*l*., and again on the 24th 1*l*., closing at 25*l*.-27*l*. *Great Wheal Fortune* shares opened on the 29th at 28*l*.-29*l*. On the 4th they advanced to 29*l*.-30*l*., but declined on the 18th to 28*l*.-29½*l*., and again on the 23rd to 27*l*.-29*l*., at which price they close. *Providence* shares have had a slight advance from 42*l*.-43*l*. to 43*l*.-45*l*. *Basset and Grylls*, 22*l*.-23*l*. *Wheal Grylls*, 28*l*.-30*l*. *Calvadnock*, 5½*l*.-6½*l*. *Wendron Consols*, 9*l*.-10*l*.

*Great Wheal Vor* shares have advanced from 7⅛*l*. to 9½*l*.-10*l*. *Wheal Kitty* (*Lelant*), 10½*l*.-11½*l*. *Wheal Margery*, 3*l*.-4*l*. *East Grylls*, 5½*l*.-6½*l*. *Rosewarne United*, 2*l*.

*East Basset* shares have improved 2*l*. upon last month's quotations. They opened at 78*l*.-80*l*. on the 29th, but fell slightly between that and the 11th, when they advanced to 80*l*.-81*l*., and after fluctuating a little, close at 80*l*.-82*l*. *Wheal Basset* shares have advanced during the month upwards of 15*l*. per share. They opened at 60*l*.-65*l*., and by the 18th had risen to 77½*l*.-82½*l*. They fell again next day to 70*l*.-75*l*., but again advanced on the 25th to their closing quotation of 77½*l*.-82½*l*. *Wheal Buller* shares have declined 10*l*. per share during the month. They opened 39½*l*.-40*l*., and close 25*l*.-30*l*. *West Basset*, 9½*l*.-10*l*. *North Basset*, 3*l*.-3¼*l*. *South Frances*, 63*l*.-64*l*. *Wheal Grenville*, 5*l*.-5½*l*. *East Grenville*, 3*l*.-3½*l*. *North Buller*, 4*l*.-5*l*. *Copper Hill*, 15*l*.-17½*l*. *South Grenville*, 5*s*.-6*s*. *South Basset*, 6*l*.-7*l*.

*North Downs* opened on the 29th at 2¼*l*.-2½*l*., but fell on the 7th to our closing quotation of last month, 1¾*l*.-2*l*., at which they have remained ever since without change. *East Carn Brea*, 7¾*l*.-8*l*. *Wheal Union*, 2⅝*l*.-2⅞*l*. *Wheal Uny*, 5¼*l*.-5½*l*. *South Tolgus*, 36*l*.-38*l*. *Great South Tolgus*, 4*l*.-4½*l*. *Carn Brea*, 65*l*.-70*l*. *North Treskerby*, 3⅛*l*.-3¾*l*.

*Clifford Amalgamated* shares have remained with little variation between 33*l*.-35*l*., closing at 33*l*.-34*l*. *Nanjiles* shares, which opened at 24*l*.-25*l*., advanced at one time to 26½*l*.-27½*l*., but fell again to 23*l*.-25*l*., at which they close. *Grambler and St. Aubyn* shares have advanced from 9*l*.-11*l*. to 13*l*.-14*l*. *North Grambler*, 4*l*.-4½*l*. *St. Day United*, 15*s*.-17*s*. 6*d*. *Great Wheal Busy*, 3¾*l*.-4*l*.

*Tincroft* shares have slightly declined on our last quotations, closing at 19½*l.*-19¾*l.* *South Crofty* shares have advanced 4*l.* per share during the month. They opened on the 29th at 19*l.*-20*l.*, and by the 15th had risen to 25*l.*-27*l.*; they fell again, however, and close at 23*l.*-24*l.* *Cooks Kitchen*, 24*l.*-25*l.* *Carn Camborne*, 1⅜*l.*-1½*l.* *Stray Park*, 37*l.*-38*l.* *Illogan Consols*, 1¼*l.*-1½*l.* *Wheal Crofty*, 3¼*l.*-3¾*l.* *Wheal Harriett*, 2½*l.*-2¾*l.* *West Stray Park*, 2½*l.*-3*l.* *Camborne Vean*, 24*l.*-25*l.*

*Wheal Seton* shares, which were pretty steady during the early part of the month, declined considerably towards the close. They opened at 217½*l.*-222½*l.*, and continued between 215*l.* and 220*l.* until the 26th, when they declined to 200*l.*-210*l.*, at which they close. *West Seton* shares have also heavily declined from 237*l.* to 200*l.*-205*l.* *West Tolgus*, 55*l.*-60*l.* *North Roskear*, 25*l.*-26*l.* *North Crofty* shares have advanced from 3½*l.*-4*l.* to 4¾*l.*-5*l.* *Wheal Agar*, 3⅜*l.*-3⅝*l.*

The following mines have also been quoted:—*Wheal Kitty* (St. Agnes), 8¼*l.*-8½*l.* *Wheal Unity*, 11*s.*-13*s.* *Tolvadden*, 1*l.*-1¼*l.* *Great Retallack*, 5*s.*-7*s.* 6*d.* *Pendeen Consols*, 6⅝*l.*-6⅞*l.* *East Rosewarne*, 2½*l.*-2¾*l.* *North Dolcoath*, 2*l.*-2½*l.*

In Welsh mines the following prices have been quoted:—*Bryn Gwiog*-31*l.*-33*l.* *Long Rake*, 4¼*l.*-4¾*l.* *Billins*, 18*l.*-19*l.* *Cambrian Consols*, 10*s.*-12*s.* 6*d.*

In Foreign and Colonial mines business has been transacted as follows:—*Yudanamutana* shares, after advancing from their opening quotation of 2¾*l.*-2⅞*l.* to 3*l.*-3⅛*l.*, close at 2⅞*l.* *Cobre Copper* shares at one time advanced to 32*l.*-32¾*l.*, but receded again to their opening quotation of 30*l.* *United Mexican*, 7⅛*l.*-7¾*l.* *Copiapo*, 8¼*l.*-8½*l.* *St. John Del Rey*, 56*l.* *Port Phillip*, 1⅜*l.* *Vallanzasca*, 1*l.* *Don Pedro North Del Rey*, 1*l.* *Mariquita*, 12*s.* 6*d.* *Linares*, 6¾*l.* *Scottish Australian*, 15*s.* *Alamillos*, 12*s.* 6*d.* *Cape Copper*, 4*l.* *East Del Rey*, 15*s.* *Kapunda*, 17*s.* 6*d.* *Worthing*, 10*s.*

DUBLIN.—The amount of business transacted in the Irish mine share market continues to be very trifling. *Wicklow Copper* shares have been in request, the old shares at 38½*l.*, and the new at 12½*l.* *Connorree* shares have declined to 16*s.* *Carysfort*, 19*s.* *Mining Company of Ireland* shares were done at 19*l.* *General Mining Company for Ireland*, nominally 4*l.* to 4½*l.*

CORNWALL.—The Cornish share market has been a little more active during the past month, but still only a very small amount of business has been transacted. *South Crofty* shares have more than recovered last month's decline. They opened at 20*l.*-21*l.*, but advance in the early part of the month to 26*l.*-27*l.* They, however, slightly receded from this, closing at 24*l.*-26*l.* *Cargoll*, 43*l.*-43½*l.* *Great Wheal Fortune*, 28*l.*-29*l.* *West Jane*, 23*s.*-25*s.* *Sithney Carnmeal*, 5*l.* *Gurlyn*, 25*s.* *Carn Brea*, 67*l.*-69*l.* *New Seton*, 95*l.*-100*l.* *South Treasvean*, 25*s.*-30*s.* *Falmouth and Sperries*, 20*s.* *Wheal Jane*, 15*l.*-16*l.* *Pedn-an-drea*, 21*s.*

## METAL MARKETS.

LONDON, *September* 28*th.*—The metal market has been active all through the month, and prices have been fully maintained.

IRON.—The iron trade has been very firm, with an advance in prices.

A large business has been done in Scotch pig-iron, which has advanced from 54*s.* 3*d.* to 59*s.* 6*d.*, cash, and from 56*s.* 3*d.* to 60*s.*, three months' prompt.

Welsh bars opened with a fair average demand at 6*l.* to 6*l.* 5*s.* f.o.b. in Wales, and close firm at 6*l.* 10*s.* f.o.b. in Wales, and 7*l.* 10*s.* in London. Staffordshire descriptions fully maintained their value, and prices have had

an upward tendency. Swedish bars have been firm, but not much in demand, and supplies have been scarce.

STEEL.—Prices of Swedish have been well maintained; although not much business has been transacted.

COPPER.—The market for his metal opened dull, but improved later on in the month, and a fair amount of business was transacted in manufactured at full prices. In foreign prices were only nominal: Burra Burra, 97*l.* to 98*l.* Kapunda, 98*l.* to 99*l.* Chili, 85*l.* to 86*l.*

YELLOW METAL.—There has been little business done in this article at unaltered quotations.

TIN.—English has been dull all through the month, and could be obtained under official rates. Straits, which at the beginning of the month could be obtained at 116*l.*, improved later on, prices closing at 117*l.* to 119*l.*, three months' prompt. Banca has been quite neglected, and has been quoted nominally at 123*l.* The Dutch market has been firm at 73½ fl. to 74fl.

TIN PLATES.—This article has been in good demand, and prices have been firmly maintained during the past month.

LEAD.—This metal has been very dull. Good soft English was to be had at one time under 20*l.*

SPELTER.—A large business was done in this article during the early part of the month, and prices advanced to 18*l.* 7*s.* 6*d.*, but towards the end of the month the market became quiet, and prices close at 18*l.* 12*s.* 6*d.* to 18*l.* 15*s.* on the spot, and 18*l.* 15*s.* for forward delivery. Hull parcels, 18*l.* 10*s.* to 18*l.* 12*s.* 6*d.*

GLASGOW, *September 26th.* IRON.—The pig-iron market has been active during the past month, and a very large amount of business has been transacted. Prices opened at 55*s.* 3*d.*, but have steadily advanced all through the early part of the month, and on the 22nd reached 59*s.* 9*d.*; they have since, however, slightly receded, closing at 59*s.* 3*d.* to 59*s.* 6*d.* The exports last month were 43,575 tons, against 35,488 tons during the corresponding period of last year—showing an increase of 8,087 tons.

BERLIN, *September 19th.*—The metal market generally has been quiet, and there is little alteration in prices to notice.

IRON.—A large amount of attention has been absorbed by Scotch pig-iron, in which a good deal of business has been done. Iron in bars, 3⅝ to 4 Thlrs. Staffordshire descriptions, 5 Thlrs.

COPPER.—The market for this metal has been tolerably active, but prices remain without change. Demidoff, 36 Thlrs.; Paschkoff, 38 Thlrs.; Mansfeld refined, 34 Thlrs.: Burra Burra, 34 Thlrs.; English, 32 to 32½ Thlrs.

TIN.—The market for this metal has been very quiet. English, 40 Thlrs. Banca, 43 Thlrs.

LEAD.—This article has been in request at 7 Thlrs.

SPELTER.—This metal has been in demand at from 5 to 5½ Thlrs.

HAMBURG, *September 17th.*—On the whole the metal market has been a little more active, although with little alteration in prices.

IRON.—Scotch pig-iron, 2¼ Mk. English in bars, 5½ to 5⅝ Mk. Staffordshire descriptions, 6½ to 6⅝ Mk.

COPPER.—This metal has fallen in price, and but little business has been done. English, best selected, 65 Mk.; Demidoff, 70 Mk.; Burra Burra and Kapunda, 67 Mk.

YELLOW METAL.—English in sheets remains unaltered at 56 Mk.

TIN.—The market for this metal still continues very quiet and prices remain at our last quotations.

SPELTER.—This article has been in fair demand, and prices have advanced to 12½ Mk.

STETTIN, *September* 19*th*. TIN.—Banca has been quoted at 45 Thlrs.

LEAD.—This article has been in more active demand at 7⅝ Thlrs.

COLOGNE, *September* 21*st*.—There is nothing new to report of the metal market here. Business has been very quiet, and prices remain unaltered.

AMSTERDAM, *September* 20*th*. TIN.—Banca continues very quiet, and has again declined to 72½ fl.

COPPER.—This metal has been quoted at 50½ to 51 fl.

PARIS, *September* 19*th*. COPPER.—The market for this metal has been inactive, and prices have had a downward tendency. English, 237½ fr. Lake Superior, 267½ fr. Chili, 220 fr.

LEAD.—This article has been quiet at slightly reduced prices. On the spot, 53½ fr.

HONG KONG, *Aug*. 12*th*. LEAD.—About 1,070 pigs, quoted $6 80c. to $7 20c.

IRON.—Nailrod, $2 60c. to $2 80c.; hoop, $3 40c. to $3 60c.; bar, $2 60c. to $4. Wire, $9 50c. to $11 50c.; sales about 2,200 piculs.

TIN PLATES.—300 boxes, at $6 30c. to $6 50c.

AMOY, *Aug*. 7*th*. LEAD.—692 pigs, at $7 50c. per picul.

FOOCHOW, *Aug*. 4*th*. LEAD.—1,320 piculs, at $8 50c. against tea.

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*Furnished by Von Dadelszen and North*, 158, *Leadenhall Street, London, E.C.*

During this present month we have to report a very animated business in every description of iron, with a large advance in price, although in other articles not more than average amount has been done.

IRON.—Welsh bars are in good demand at 6*l*. 10*s*. f.o.b. in Wales, whilst 7*l*. 10*s*. is the lowest price at which they can be bought here. Staffordshire descriptions are very firm, and are difficult to obtain early; the price has been officially advanced altogether 30*s*. per ton from the lowest point. Scotch pigs have been dealt in to a large extent, and an improvement of 5*s*. 6*d*. per ton has been established, closing at 59*s*. 6*d*. cash, and 60*s*. three months open.

COPPER.—In this article an improved tone is observable; English manufactured is in good demand at fixed quotations, although second hand parcels of raw are obtainable slightly below the official price. Not much business is doing in foreign; we quote Burra, 98*l*.; Kapunda, 99*l*., both nominal. On the whole there is much better feeling.

TIN.—The market is very quiet; Straits after having been done as low as 114*l*. 10*s*. has since rallied to 118*l*. cash, and closes 117*l*. cash, and 119*l*. three months' prompt sellers. English in fair demand.

TIN PLATES are in improved demand for common coke qualities, and higher prices are asked. Charcoal remain flat.

LEAD.—For good soft English 20*l*. to 20*l*. 5*s*. is asked.

SPELTER.—The market for this article has been quiet during the last few days, although holders are firm at 18*l*. 12*s*. 6*d*. for spot parcels here, and in Hull, 18*l*. 10*s*.; forward 18*l*. 15*s*.

## PRICES CURRENT OF METALS.

From Messrs. JAMES and SHAKSPEARE'S, 10, Austin Friars, E.C., 28*th Sept.*

| | | | | |
|---|---|---|---|---|
| | | | Per Ton. | |
| IRON .......... | Bars (Welch) .. in Wales .. | £6 10 0 | @ | £6 15 0 |
| | " " .. " Liverpool | —— | " | 7 5 0 |
| | " " .. " London | 7 10 0 | " | 7 15 0 |
| | Nail Rods " .. " Wales . | 7 0 0 | " | 7 5 0 |
| | " (Staffordshire) " Liverpool | 8 12 6 | " | 9 2 6 |
| | " " " London | 9 0 0 | " | 9 10 0 |
| | Hoops " " Liverpool | 9 12 6 | " | 10 2 6 |
| | " " " London | 10 0 0 | " | 10 10 0 |
| | Sheets " " Liverpool | 10 12 6 | " | 11 2 6 |
| | " " " London | 11 0 0 | " | 11 10 0 |
| | Bars " " Liverpool | 8 12 6 | " | 9 2 6 |
| | " " " London | 9 0 0 | " | 9 10 0 |
| | Scotch Pig (No. 1. g.m.b.) the Clyde | —— | " | 2 18 6 |
| | Rails ................ in Wales | —— | " | 6 15 0 |
| | Swedish—Hammered—large sizes | 11 7 6 | " | 11 10 0 |
| | " " Indian assortments | —— | " | 11 10 0 |
| STEEL ........ | " " Hammered—faggot | 16 10 0 | " | 17 0 0 |
| | " " in kegs (¼ and ⅝ in.) | 15 10 0 | " | 16 0 0 |
| COPPER ...... Australian .. | Burra and P.C.C. ............ | —— | " | 98 0 0 |
| | Kapunda .................. | 100 0 0 | " | 101 0 0 |
| | Wallaroo ................. | —— | " | 98 0 0 |
| American.... | Baltimore ................. | —— | " | none |
| | Lake Superior .............. | —— | " | " |
| | Spanish Cake................ | 91 0 0 | " | 92 0 0 |
| | Chili and other Slab (for 96 per cent. pure Copper) ........ | —— | " | 87 0 0 |
| English .... | Tough Cake and Ingot and Tile | —— | " | 95 0 0 |
| | Best selected Ingot .......... | —— | " | 98 0 0 |
| | Sheets, Sheathing and Rod .... | —— | " | 102 0 0 |
| | Flat Bottoms............... | —— | " | 107 0 0 |
| | | | Per lb. | |
| YELLOW METAL.. | Sheets .................... | 8*d.* | @ | 8¼*d.* |
| | Sheathing and Rod ........ | 8¾*d.* | " | 9*d.* |
| | | | Per Cwt. | |
| TIN ......... English .. | Common Blocks and Ingots .... | —— | @ | 115*s.* |
| | " Bars (in barrels) ...... | —— | " | 116*s.* |
| | Refined .................... | —— | " | 120*s.* |
| Foreign .. | Straits, Fine ................ | —— | " | 118*s.* |
| | " (with 3 months' prompt) | —— | " | 120*s.* |
| | Banca ..................... | —— | " | 123*s.* |
| | | | Per Box. | |
| TIN PLATES at Liverpool 6*d.* Less | Charcoal IC, best.............. | 28*s.* 6*d.* | @ | 29*s.* 6*d.* |
| | " IX " .............. | 34*s.* 6*d.* | " | 35*s.* 6*d.* |
| | Coke IC .................. | 23*s.* 6*d.* | " | 25*s.* 6*d.* |
| | " IX .................. | 29*s.* 6*d.* | " | 31*s.* 6*d.* |
| | | | Per Ton. | |
| LEAD........ English .. | Sheet ...................... | —— | @ | £20 10 0 |
| | Pig—W.B. .................. | —— | " | 21 7 6 |
| | " Other good brands ........ | £20 0 0 | " | 20 5 0 |
| | " German and Spanish, soft .. | —— | " | 19 5 0 |
| English .. | Red ...................... | —— | " | 21 5 0 |
| | Shot ...................... | —— | " | 23 0 0 |
| | Dry White.................. | —— | " | 26 0 0 |
| SPELTER ...... | (Silesian) in Cakes ............ | —— | " | 18 15 0 |
| ZINC .......... | (Sheet) No. 9 and upwards .... | 24 5 0 | " | 24 10 0 |
| | | | Per Bottle. | |
| QUICKSILVER | (in bottles containing 75lbs. each) | —— | @ | 7 0 0 |
| | | | Per Ton. | |
| REGULUS OF ANTIMONY, | French Star ...... | —— | @ | 39 0 0 |

# Tabular Abstract of Mining Accounts for the Month.

| Date of Account. | Name of Mine, and Number of Shares. | Balances. | | Calls. | | Dividends. | |
|---|---|---|---|---|---|---|---|
| | | Debit. | Credit. | Per Share. | Total. | Per Share. | Total. |
| | CORNISH & DEVON MINES. | £ s. d. | £ s. d. | £ s. d | £ s. d. | £ s. d. | £ s. d. |
| Aug. 18 | St. Ives Consols (940) ......... | — | 1,727 11 0 | — | — | 1 0 0 | 940 0 0 |
| " 18 | Levant (160) ..................... | — | 34 0 0 | — | — | — | — |
| " 19 | East Alfred Consols (4,096) ... | 771 0 0 | — | — | — | — | — |
| " 19 | Botallack (200) .................. | — | 2,509 6 8 | — | — | 7 0 0 | 1,400 0 0 |
| " 21 | Wheal Owles (80) ............... | — | 2,057 13 3 | — | — | 5 0 0 | 400 0 0 |
| " 24 | Bronfloyd (5,000) ............... | — | — | — | — | 0 2 6 | 625 0 0 |
| " 24 | Great Work (119) ............... | 80 0 1 | — | — | — | — | — |
| " 24 | East Carn Brea (6,000)......... | 99 0 1 | — | 0 1 0 | 300 0 0 | — | — |
| " 24 | Hingston Down Consols (6,000) ........................... | 274 4 1 | — | — | — | — | — |
| " 24 | Pendeen Consols (5,000) ...... | — | 1,529 0 0 | 0 4 0 | 1,000 0 0 | — | — |
| " 24 | Wheal Union (6,000)............ | 551 10 7 | — | 0 3 0 | 900 0 0 | — | — |
| " 24 | South Crofty (937)............... | — | — | 0 15 0 | 702 15 0 | — | — |
| " 24 | North Buller (1,024) ............ | 293 0 0 | — | 0 12 6 | 640 0 0 | — | — |
| " 25 | Illogan Consols (6,000) ......... | 406 0 0 | — | 0 2 6 | 750 0 0 | — | — |
| " 25 | Trelawny (1,040) ............... | — | 1,071 7 8 | — | — | 0 10 0 | 520 0 0 |
| " 25 | Tincroft (6,000) .................. | — | — | — | — | 1 0 0 | 6,000 0 0 |
| " 25 | Wheal Mary Hutchings (1,000) | — | 112 17 0 | — | — | — | — |
| " 25 | North Basset (6,000) ........... | 162 15 10 | — | — | — | 0 3 0 | 900 0 0 |
| " 26 | Providence (1,120)............... | — | 2,133 12 0 | — | — | 1 5 0 | 1,400 0 0 |
| " 26 | North Downs (6,000)............ | 628 4 1 | — | 0 2 6 | 750 0 0 | — | — |
| " 27 | Basset and Grylls (1,000) ...... | — | — | 0 10 0 | 500 0 0 | — | — |
| " 27 | Drakewalls (12,500) ............ | — | 918 4 3 | — | — | — | — |
| " 28 | Boscaswell (1,248) .............. | — | 728 10 7 | — | — | — | — |
| " 28 | Garden (1,026) .................. | 581 9 0 | — | — | — | 5 0 0 | 312 0 0 |
| " 29 | New Hendra (400) ............... | — | 27 15 4 | 0 5 0 | 100 0 0 | — | — |
| " 31 | Wheal Jane (512) ............... | — | 298 0 7 | — | — | — | — |
| " 31 | East Pool (128) .................. | — | 746 3 9 | — | — | 5 0 0 | 640 0 0 |
| " 31 | St. Aubyn and Grylls (792) ... | 253 3 8 | — | — | — | — | — |
| Sept. 2 | Trelyon Consols (572) ......... | 61 14 5 | — | — | — | — | — |
| " 2 | Condurrow (256) ................ | 3,575 0 3 | — | — | — | — | — |
| " 3 | Great Wheal Busy (6,000) ... | 181 0 0 | — | — | — | — | — |
| " 3 | Boscawen (6,000) ............... | 1,467 0 0 | — | 0 5 0 | 1,500 0 0 | — | — |
| " 3 | West Sharp Tor (256) ......... | — | 255 7 11 | 0 3 0 | 38 8 0 | — | — |
| " 4 | Treweatha (4,096) .............. | 717 18 0 | — | 0 3 0 | 614 8 0 | — | — |
| " 5 | Clijah and Wentworth (787)... | 164 10 1 | — | 0 5 0 | 196 15 0 | — | — |
| " 8 | Wheal Mary Ann (1,024) ...... | — | 1,207 8 0 | — | — | — | — |
| " 8 | Grambler & St. Aubyn (486) | 514 0 0 | — | 1 0 0 | 486 0 0 | — | — |
| " 8 | Pedn-an-drea United (8,465) | — | 4 10 7 | — | — | — | — |
| " 8 | Boscean (240)...................... | — | 193 19 2 | — | — | — | — |
| " 9 | West Caradon (1,024) ......... | — | 2,520 11 2 | — | — | — | — |
| " 10 | Frank Mills (5,000) ............ | — | 1,088 4 9 | — | — | — | — |
| " 10 | Great Briggan (5,000) ......... | 2,983 15 8 | — | 0 10 0 | 2,500 0 0 | — | — |
| " 10 | Great North Downs (5,000) ... | 2,488 12 8 | — | 0 10 0 | 2,500 0 0 | — | — |
| " 10 | Chiverton (3,000) ............... | — | 3,361 13 6 | — | — | — | — |
| " 11 | Caradon Consols (914) ......... | 62 3 10 | — | 0 12 6 | 571 5 0 | — | — |
| " 11 | New Birch Tor and Vitifer Consols (6,000) ............... | — | 749 18 0 | — | — | 0 2 0 | 600 0 |
| " 11 | North Levant (2,000) ......... | 673 5 6 | — | 0 5 0 | 500 0 0 | — | — |
| " 14 | Wheal Grylls (1,024)........... | — | 1,462 0 0 | — | — | 1 0 0 | 1,024 0 |
| " 14 | East Grylls (2,048).............. | — | 1,635 0 0 | — | — | — | — |
| " 14 | Roskear (6,000) .................. | — | — | 0 10 0 | 3,000 0 0 | — | — |
| " 15 | North Roskear (700)............ | 1,430 7 8 | — | 0 2 0 | 70 0 0 | — | — |
| " 15 | Roskearnoweth (700)........... | — | 219 12 4 | — | — | — | — |
| " 15 | Treworlis (2,048)................ | 845 0 0 | — | 8 0 0 | 819 4 0 | — | — |
| " 15 | East Wheal Lovel (1,906)...... | — | 779 0 0 | — | — | 0 7 6 | 714 15 0 |
| " 16 | Great Caradon (4,096) ......... | — | 25 0 10 | 0 2 0 | 409 12 0 | — | — |
| " 16 | East Agar (1,190) ............... | 315 0 0 | — | 0 15 0 | 892 10 0 | — | — |
| " 16 | Wheal Uny (4,096)............... | — | 434 5 6 | — | — | — | — |
| " 16 | Great Wheal Vor (5,908)...... | — | 4,164 0 0 | — | — | 0 5 0 | 1,477 0 0 |
| " 16 | Wheal Margery (968) ......... | 686 18 2 | — | 0 15 0 | 726 0 0 | — | — |
| " 17 | West Kitty (St. Agnes) (5,000) | — | — | 0 5 0 | 1,250 0 0 | — | — |
| " 18 | Wheal Hope (2,048) ............ | 490 11 1 | — | 0 5 0 | 512 0 0 | — | — |
| | WELSH & OTHER MINES. | | | | | | |
| Aug. 7 | Minera (1,800)..................... | — | — | — | — | 7 15 0 | 13,950 0 0 |
| " 26 | Erwfelin (2,000)................... | — | 1 5 4 | — | — | — | — |
| " 31 | St. David's Gold (40,000) ...... | — | 2,295 0 8 | — | — | — | — |
| " 31 | Wicklow Copper (5,000) ...... | — | — | — | — | 1 6 0 | 6,500 0 0 |
| Sept. 2 | Lantwit Vardre (4,000)......... | — | 998 18 0 | — | — | — | — |
| " 17 | Maudlin (6,000) .................. | — | — | 0 3 0 | 900 0 0 | — | — |
| | FOREIGN MINES. | | | | | | |
| Aug. 23 | Santa Barbara Gold (60,000) | — | 7,484 5 4 | — | — | — | — |
| " 31 | Fortune Copper (40,000) ...... | — | 7,395 10 10 | — | — | — | — |

# Copper Ores.

Sampled Aug. 12, an sold at Tabb's Hotel, Redruth, Aug. 27.

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| South Caradon ......... | 92 | 7 | £5 | 19 | 6 |
| | 87 | 7 | 8 | 14 | 6 |
| | 71 | 11 | 5 | 13 | 6 |
| | 70 | 9 | 8 | 14 | 0 |
| | 54 | 1 | 15 | 3 | 6 |
| | 47 | 1, 5, 6 | 16 | 1 | 0 |
| | 36 | 9 | 8 | 8 | 6 |
| | 24 | 10 | 5 | 16 | 6 |
| Great Wheal Busy ... | 71 | 7, 8 | 2 | 12 | 0 |
| | 69 | 7, 12 | 2 | 0 | 6 |
| | 65 | 8 | 1 | 17 | 6 |
| | 53 | 3 | 3 | 10 | 0 |
| | 51 | 6 | 3 | 6 | 0 |
| | 48 | 12 | 1 | 18 | 6 |
| | 39 | 8 | 2 | 19 | 0 |
| | 29 | 2, 7 | 2 | 7 | 0 |
| Fowey Consols ......... | 88 | 6 | 5 | 10 | 6 |
| | 82 | 9 | 5 | 9 | 0 |
| | 77 | 1 | 5 | 6 | 0 |
| | 56 | 10 | 4 | 7 | 6 |
| | 52 | 12 | 1 | 10 | 6 |
| | 45 | 12 | 1 | 8 | 6 |
| West Damsel............ | 79 | 3 | 3 | 8 | 0 |
| | 76 | 8 | 3 | 11 | 0 |
| | 71 | 6, 11, 13 | 3 | 12 | 6 |
| | 65 | 3 | 3 | 6 | 0 |
| | 47 | 3 | 4 | 2 | 0 |
| | 45 | 2 | 2 | 19 | 6 |
| Tywarnhaile ............ | 90 | 13 | 3 | 7 | 0 |

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| Tywarnhaile ............ | 60 | 2 | £4 | 1 | 0 |
| | 54 | 3 | 10 | 0 | 6 |
| | 44 | 8 | 5 | 14 | 6 |
| | 37 | 12 | 2 | 1 | 0 |
| Clifford Amalgamated | 63 | 10 | 3 | 15 | 6 |
| | 59 | 8 | 3 | 14 | 0 |
| | 55 | 11 | 4 | 18 | 6 |
| | 32 | 8 | 0 | 3 | 6 |
| | 26 | 1, 5 | 12 | 18 | 6 |
| | 18 | 7, 14 | 2 | 10 | 0 |
| | 10 | 7 | 4 | 17 | 0 |
| Craddock Moor......... | 87 | 6 | 6 | 1 | 6 |
| | 82 | 1, 5 | 8 | 12 | 0 |
| | 20 | 10 | 3 | 9 | 0 |
| | 17 | 10 | 5 | 1 | 6 |
| New Treleigh ......... | 44 | 3 | 2 | 12 | 6 |
| | 43 | 7 | 3 | 1 | 6 |
| | 27 | 7 | 7 | 18 | 0 |
| Great North Downs... | 74 | 8 | 4 | 13 | 0 |
| Great Brigan........... | 56 | 6, 13 | 5 | 15 | 6 |
| | 11 | 3 | 2 | 9 | 0 |
| Boscawen ............... | 50 | 5, 9 | 5 | 11 | 6 |
| Pedn-an-drea ......... | 36 | 7 | 4 | 6 | 0 |
| Falmouth & Sperries | 35 | 1, 5 | 4 | 10 | 0 |
| North Grambler ...... | 25 | 3 | 5 | 9 | 0 |
| Buckingham's Ore ... | 15 | 5 | 2 | 13 | 0 |
| | 1 | 5 | 19 | 5 | 0 |
| North Hallenbeagle... | 12 | 3 | 6 | 18 | 6 |

TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| South Caradon ............. | 481 | £4,337 | 12 | 0 |
| Great Wheal Busy.......... | 425 | 1,075 | 12 | 0 |
| Fowey Consols ............ | 400 | 1,729 | 12 | 6 |
| West Damsel ............... | 383 | 1,336 | 17 | 0 |
| Tywarnhaile ............... | 285 | 1,413 | 12 | 0 |
| Clifford Amalgamated ... | 263 | 1,162 | 3 | 0 |
| Craddock Moor ............ | 206 | 1,389 | 0 | 0 |
| New Treleigh ...... ........ | 114 | 461 | 0 | 6 |
| Great North Downs......... | 74 | £344 | 2 | 0 |
| Great Brigan ............... | 67 | 350 | 7 | 0 |
| Boscawen ...................... | 50 | 278 | 15 | 0 |
| Pedn-an-drea ............... | 36 | 154 | 16 | 0 |
| Falmouth and Sperries ... | 35 | 157 | 10 | 0 |
| North Grambler ............ | 25 | 136 | 5 | 0 |
| Buckingham's Ore ......... | 16 | 59 | 0 | 0 |
| North Hallenbeagle ...... | 12 | 83 | 2 | 0 |

EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| 1 Vivian and Sons ......... | 218½ | £2,708 | 7 | 6 |
| 2 Freeman and Co. ...... | 119½ | 410 | 19 | 0 |
| 3 Grenfell and Sons ...... | 390 | 1,764 | 9 | 0 |
| 4 Crown Copper Co. ...... | — | —— | | |
| 5 Sims, Willyams & Co. ... | 112½ | 990 | 4 | 0 |
| 6 Williams, Foster & Co. | 309½ | 1,740 | 19 | 4 |
| 7 Mason and Elkington ... | 388½ | 2,076 | 6 | 9 |
| 8 Bankart and Sons ...... | 424½ | 1,418 | 18 | 6 |
| 9 Copper Miners' Co. ...... | 213 | £1,498 | 11 | 6 |
| 10 Charles Lambert ......... | 180 | 777 | 13 | 0 |
| 11 Newton, Keates & Co... | 149½ | 759 | 11 | 10 |
| 12 Sweetland, Tuttle & Co. | 216¼ | 881 | 10 | 9 |
| 13 Neath Copper Co. ...... | 141½ | 648 | 19 | 10 |
| 14 Penclawdd Copper Co. | 9 | 22 | 10 | 0 |
| Total ............... | 2,872 | £14,469 | 6 | 0 |

Average Produce, 6⅛.
Quantity of Fine Copper, 139 tons 0 cwts.

Average Standard ..................£118 7 0
Average Price per ton ............ 5 0 6

# Sundry Copper Ore Sales.

| Dates. | Mines. | Tons. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|
| July 31. | Great Laxey (Isle of Man ...... | 55 ... | 3 | 13 | 0 ... | St. Helen's Co............. | 636 | 5 | 0 |
| | " " ...... | 32 ... | 4 | 0 | 0 ... | J. Radley ................ | | | |
| | " " ...... | 100 ... | 2 | 17 | 6 ... | ditto .................. | | | |
| Aug. 15. | " " ...... | 32 ... | 3 | 15 | 0 ... | St. Helen's Co............... | 120 | 0 | 0 |
| " 18. | Lot 1 (Parys Mines) ............ | 160 ... | 5 | 19 | 0 ... | Newton, Keates & Co. | 1,872 | 0 | 0 |
| | 2 " ............ | 160 ... | 5 | 19 | 0 ... | Mona Co. .................. | | | |
| | 3 " ............ | 50 ... | 6 | 12 | 0 ... | ditto .................. | | | |
| | 4 " ............ | 30 ... | 3 | 7 | 0 ... | ditto .................. | | | |
| " 26. | West Canada Co. (J.G. Deshler) | 60 ... | 17 | 2 | 0 ... | C. Lambert ............... | 5,490 | 5 | 0 |
| | " " ...... | 60 ... | 17 | 2 | 0 ... | ditto ............... | | | |
| | " " ...... | 60 ... | 17 | 4 | 6 ... | Bibby, Sons & Co. ...... | | | |
| | " " ...... | 50 ... | 17 | 0 | 0 ... | ditto ...... | | | |
| | " " ...... | 90 ... | 17 | 5 | 6 ... | ditto ...... | | | |
| | Knockmahon (Johanna)......... | 65 ... | 10 | 5 | 6 ... | Newton, Keates & Co. | 2,199 | 13 | 6 |
| | " " ......... | 65 ... | 10 | 7 | 6 | Bibby, Sons & Co. ...... / Pocket Nook Co.......... | | | |
| | " (Ellen) ............ | 55 ... | 8 | 2 | 6 ... | ditto .......... | | | |
| | " " ............ | 50 ... | 8 | 4 | 6 ... | Bibby, Sons, & Co....... | | | |
| Sept. 15. | Parys Mines ....................... | 165 ... | 5 | 3 | 0 ... | Mona Co. ................... | 1,699 | 10 | 0 |
| | " ....................... | 165 ... | 5 | 3 | 0 ... | ditto .................. | | | |

# Copper Ores.

**Sampled Aug. 19, and sold at Tyack's Hotel, Camborne, Sept. 3.**

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| Clifford Amalgamated | 102 | 7 | £4 | 16 | 0 |
| | 101 | 7 | 7 | 6 | 0 |
| | 100 | 10 | 3 | 15 | 6 |
| | 90 | 9 | 4 | 0 | 6 |
| | 80 | 3 | 7 | 9 | 6 |
| | 74 | 3 | 7 | 16 | 6 |
| | 73 | 8 | 4 | 9 | 6 |
| | 70 | 7 | 4 | 10 | 0 |
| | 65 | 7 | 7 | 4 | 0 |
| | 64 | 8, 14 | 3 | 15 | 6 |
| | 40 | 7, 12 | 3 | 5 | 6 |
| | 24 | 3 | 2 | 11 | 6 |
| | 22 | 7 | 5 | 0 | 0 |
| West Seton | 82 | 3 | 4 | 9 | 6 |
| | 63 | 9, 12 | 2 | 11 | 6 |
| | 61 | 6, 13 | 7 | 4 | 6 |
| | 59 | 14 | 7 | 0 | 0 |
| | 57 | 8 | 5 | 5 | 6 |
| | 48 | 8, 10 | 3 | 16 | 6 |
| | 46 | 14 | 7 | 10 | 6 |
| Wheal Seton | 26 | 3 | 6 | 10 | 6 |
| | 21 | 7 | 1 | 7 | 0 |
| (Pendarves) | 110 | 1 | 0 | 12 | 6 |
| | 70 | 3 | 5 | 3 | 0 |
| | 50 | 6 | 6 | 11 | 6 |
| | 49 | 10 | 3 | 17 | 0 |
| | 47 | 9 | 5 | 2 | 6 |
| | 15 | 1, 5 | 13 | 14 | 0 |
| | 5 | 5 | 2 | 1 | 6 |
| South Tolgus | 82 | 5 | 3 | 16 | 6 |
| | 67 | 10 | 4 | 2 | 6 |
| | 47 | 1 | 9 | 3 | 6 |
| | 36 | 1, 6 | 3 | 19 | 6 |

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| South Tolgus | 33 | 7, 8 | £3 | 17 | 6 |
| East Pool | 87 | 10 | 4 | 4 | 6 |
| | 77 | 5 | 3 | 19 | 6 |
| | 73 | 9 | 3 | 18 | 6 |
| North Roskear | 55 | 12 | 4 | 1 | 0 |
| | 53 | 1, 2, 6 | 6 | 17 | 0 |
| | 51 | 10 | 1 | 19 | 6 |
| | 49 | 1, 5 | 10 | 12 | 6 |
| Tolcarne | 59 | 13 | 5 | 3 | 6 |
| | 55 | 5 | 3 | 18 | 0 |
| | 48 | 9 | 2 | 8 | 6 |
| | 22 | 9 | 2 | 4 | 0 |
| South Frances | 59 | 1 | 6 | 0 | 6 |
| | 45 | 1, 6 | 8 | 9 | 6 |
| | 42 | 10 | 4 | 7 | 0 |
| | 5 | 5 | 3 | 1 | 0 |
| Wheal Basset | 69 | 1, 5 | 5 | 17 | 6 |
| | 33 | 13 | 6 | 0 | 0 |
| | 21 | 1, 3, 5, 7 | 7 | 16 | 6 |
| East Basset | 40 | 1, 5 | 7 | 12 | 0 |
| | 27 | 3 | 14 | 8 | 0 |
| | 17 | 1 | 10 | 13 | 0 |
| North Crofty | 45 | 7 | 1 | 3 | 6 |
| | 24 | 2, 6 | 5 | 16 | 0 |
| Wheal Harriett | 40 | 7 | 1 | 16 | 0 |
| | 28 | 6 | 5 | 6 | 6 |
| West Stray Park | 42 | 6, 7 | 4 | 2 | 0 |
| | 28 | 6 | 7 | 4 | 0 |
| West Tolgus | 43 | 10 | 5 | 18 | 0 |
| Wheal Towan | 20 | 1 | 2 | 3 | 6 |
| North Dolcoath | 16 | 9 | 6 | 11 | 0 |
| South Basset | 13 | 8, 12 | 3 | 1 | 6 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | | | Tons. | Amount. |
|---|---|---|---|---|---|---|---|
| Clifford Amalgamated | 905 | £4,997 15 6 | | East Basset | 84 | £873 17 0 |
| West Seton | 416 | 2,213 6 6 | | North Crofty | 69 | 192 1 6 |
| Wheal Seton | 393 | 1,601 8 0 | | Wheal Harriett | 68 | 221 2 0 |
| South Tolgus | 265 | 1,472 4 6 | | West Stray Park | 65 | 337 16 0 |
| East Pool | 237 | 960 3 6 | | West Tolgus | 43 | 253 14 0 |
| North Roskear | 208 | 1,207 3 0 | | Wheal Towan | 20 | 43 10 0 |
| Tolcarne | 184 | 684 12 6 | | North Dolcoath | 16 | 104 14 0 |
| South Frances | 151 | 934 16 0 | | South Basset | 13 | 39 19 6 |
| Wheal Basset | 128 | 767 14 0 | | | | |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Vivian and Sons | 402½ | £2,311 11 9 | 9 Copper Miners' Co. | 327½ | £1,240 7 3 |
| 2 Freeman and Co. | 99¾ | 551 2 4 | 10 Charles Lambert | 463 | 1,839 0 6 |
| 3 Grenfell and Sons | 318¼ | 2,205 6 8 | 11 Newton, Keates & Co. | — | — |
| 4 Crown Copper Co. | — | — | 12 Sweetland, Tuttle & Co. | 113 | 489 7 0 |
| 5 Sims, Willyams & Co. | 315¾ | 1,618 3 7 | 13 Neath Copper Co. | 122½ | 723 13 9 |
| 6 Williams, Foster & Co. | 222¾ | 1,493 15 4 | 14 Penclawdd Copper Co. | 137 | 879 19 0 |
| 7 Mason and Elkington | 528¾ | 2,629 14 10 | | | |
| 8 F. Bankart | 209 | 923 17 6 | Total | 3,260 | £16,905 19 6 |

**Average Produce, 6¼.**
**Quantity of Fine Copper, 223 tons 12 cwts.**

**Average Standard ................ £115 14 0**
**Average Price per ton ............ 5 4 0**

# Blende Sales.

| Date. | Mines. | Tons. | Price per ton. £ s. d. | Purchasers. | Amount of Money. £ s. d. |
|---|---|---|---|---|---|
| Sept. 4. | Minera | 30 | 3 1 6 | H. Southern | 278 7 6 |
| | ,, | 48 | 3 14 6 | A. Courage | |
| | ,, | 19 | 2 0 6 | W. Kenrick | |
| | ,, | 17 | 4 1 0 | Vivian & Sons | |

# Copper Ores.

**Sampled Aug. 26, and sold at Tabb's Hotel, Redruth, Sept. 10.**

| Mines. | Tons. | Purchasers. | Price. | Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|---|---|---|---|
| West Basset | 78 | 7 | £7 19 6 | East Rosewarne | 22 | 6 | £2 8 6 |
| | 77 | 1, 5 | 6 19 6 | Wheal Uny | 53 | 3 | 6 9 6 |
| | 76 | 7, 10 | 3 5 6 | | 52 | 9 | 6 2 6 |
| | 64 | 12 | 3 19 6 | Copper Hill | 59 | 10 | 1 13 0 |
| | 52 | 7 | 6 18 6 | | 26 | 1 | 6 4 6 |
| | 43 | 5 | 7 1 6 | Wheal Anna | 56 | 5, 6 | 5 2 6 |
| | 36 | 1 | 7 10 6 | | 15 | 12 | 3 7 6 |
| East Carn Brea | 58 | 3, 6, 7 | 3 9 0 | Tolvadden | 30 | 6 | 4 16 6 |
| | 53 | 6 | 5 16 6 | | 26 | 10 | 3 0 0 |
| | 47 | 10 | 5 7 0 | | 8 | 8 | 8 17 0 |
| | 46 | 2, 3 | 4 2 6 | North Basset | 33 | 8 | 3 17 0 |
| | 45 | 7 | 4 10 0 | | 11 | 8 | 4 5 6 |
| | 28 | 2, 6, 7 | 4 19 0 | | 8 | 5 | 0 15 6 |
| | 18 | 3 | 2 17 6 | Gurlyn | 52 | 10 | 4 17 0 |
| | 14 | 2 | 3 9 0 | Wheal Buller | 43 | 7 | 3 2 0 |
| Wheal Margery | 80 | 1, 6 | 6 6 6 | | 5 | 1 | 14 3 0 |
| | 57 | 5, 6, 10 | 1 19 6 | North Frances | 18 | 10 | 1 1 0 |
| | 55 | 5 | 1 18 0 | | 13 | 1, 10 | 5 4 6 |
| | 48 | 5, 10 | 2 1 6 | Nangiles | 30 | 9 | 5 5 0 |
| Par Consols | 66 | 3 | 6 7 6 | West Alfred Consols | 26 | 1 | 1 8 6 |
| | 64 | 3 | 6 6 6 | West Trevellyan | 20 | 1 | 8 11 6 |
| | 63 | 1, 5 | 1 13 0 | Wh. Emily Henrietta | 20 | 9 | 6 10 0 |
| Prosper United | 73 | 6 | 3 16 6 | South Carn Brea | 16 | 12 | 2 14 6 |
| | 47 | 1 | 2 0 0 | Wheal Agar | 15 | 10 | 5 5 0 |
| | 46 | 2, 6 | 5 1 0 | Boiling Wells | 15 | 10 | 1 12 0 |
| | 25 | 5 | 3 12 6 | Crowan Consols | 7 | 12 | 1 10 6 |
| East Rosewarne | 36 | 7 | 7 6 0 | | 6 | 3 | 0 15 0 |
| | 28 | 2 | 7 7 0 | Wheal Union | 11 | 9 | 3 17 6 |
| | 27 | 1 | 10 14 0 | West Par Consols | 4 | 1 | 14 18 0 |
| | 25 | 3 | 6 10 0 | Pembroke | 2 | 1 | 1 4 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| West Basset | 426 | £2,597 13 0 | North Frances | 31 | £86 16 6 |
| East Carn Brea | 309 | 1,391 3 6 | Nangiles | 30 | 157 10 0 |
| Wheal Margery | 240 | 822 13 6 | West Alfred | 26 | 37 1 0 |
| Par Consols | 193 | 929 10 0 | West Trevelyan | 20 | 171 10 0 |
| Prosper United | 191 | 696 3 0 | Wheal Emily Henrietta | 20 | 130 0 0 |
| East Rosewarne | 138 | 970 7 0 | South Carn Brea | 16 | 43 12 0 |
| Wheal Uny | 105 | 661 13 6 | Wheal Agar | 15 | 78 15 0 |
| Copper Hill | 85 | 259 4 0 | Boiling Well | 15 | 24 0 0 |
| Wheal Anna | 71 | 337 12 6 | Crowan Consols | 13 | 15 3 6 |
| Tolvadden | 64 | 293 11 0 | Wheal Union | 11 | 44 7 0 |
| North Basset | 52 | 180 5 6 | West Par Consols | 4 | 59 12 0 |
| Gurlyn | 52 | 252 4 0 | Pembroke | 2 | 2 9 0 |
| Wheal Buller | 48 | 204 1 0 | | | |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Vivian and Sons | 309½ | £1,764 9 6 | 9 Copper Miners' Co. | 113 | £648 7 0 |
| 2 Freeman and Co. | 97½ | 511 6 6 | 10 Charles Lambert | 319¼ | 1,046 7 9 |
| 3 Grenfell and Sons | 274½ | 1,549 1 0 | 11 Newton, Keates & Co. | — | —— |
| 4 Crown Copper Co. | — | —— | 12 Sweetland, Tuttle & Co. | 102 | 359 6 0 |
| 5 Sims, Willyams & Co. | 272 | 1,056 17 9 | 13 Neath Copper Co. | — | —— |
| 6 Williams, Foster & Co. | 316¾ | 1,449 2 6 | 14 Penclawdd Copper Co. | — | —— |
| 7 Mason and Elkington | 372¾ | 2,059 19 6 | | | |
| 8 Bankart and Sons | — | —— | Total | 2,177 | £10,444 17 6 |

Average Produce, 6¼.
Quantity of Fine Copper, 142 tons 8 cwts.

Average Standard ........ £115 8 0
Average Price per ton ........ 4 16 0

# Copper Ores.

**Sampled Sept. 2, and sold at the Royal Hotel, Truro, Sept. 17.**

| Mines. | Tons. | Purchasers. | Price. | Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|---|---|---|---|
| Devon Great Consols... | 145 | 5 | £4 16 6 | New Wheal Martha ... | 80 | 1, 5 | £2 4 6 |
| | 138 | 3 | 5 5 6 | | 75 | 1, 3, 5 | 2 4 6 |
| | 124 | 2 | 4 9 6 | | 52 | 3 | 2 3 6 |
| | 123 | 5 | 4 5 6 | | 20 | 3 | 5 17 6 |
| | 122 | 1 | 4 4 6 | Hingston Down ......... | 84 | 9 | 2 13 0 |
| | 120 | 9 | 4 5 0 | | 83 | 10 | 2 12 6 |
| | 116 | 1, 5 | 4 4 6 | | 72 | 10 | 2 5 6 |
| | 115 | 1, 6, 10 | 4 4 6 | | 71 | 11 | 4 0 0 |
| | 112 | 3 | 4 18 0 | | 65 | 3, 10 | 2 3 6 |
| | 110 | 3 | 4 6 0 | | 35 | 3 | 7 17 6 |
| | 109 | 12 | 3 6 6 | Marke Valley ............ | 87 | 6 | 3 6 6 |
| | 107 | 6 | 4 10 6 | | 86 | 2, 9 | 2 9 0 |
| | 106 | 6, 11 | 3 17 6 | | 66 | 1, 12 | 3 1 6 |
| | 104 | 5 | 4 3 0 | | 54 | 2 | 3 11 0 |
| | 93 | 8 | 4 8 6 | | 50 | 10 | 2 5 0 |
| | 89 | 1, 10 | 2 5 6 | | 30 | 6 | 6 5 6 |
| | 80 | 6 | 5 10 6 | | 29 | 1, 10 | 1 5 6 |
| | 73 | 1, 6 | 10 11 6 | Wheal Edward ......... | 65 | 5, 6 | 4 14 0 |
| | 68 | 6 | 3 15 0 | | 53 | 12 | 2 0 6 |
| | 64 | 7 | 1 19 0 | | 48 | 8, 14 | 3 12 6 |
| | 59 | 8 | 4 10 6 | | 40 | 9 | 3 5 0 |
| | 52 | *1, 10 | 2 16 6 | | 16 | 12 | 3 8 6 |
| | 40 | 1 | 2 4 6 | East Russell............... | 130 | 1 | 3 15 6 |
| | 39 | 1, 6, 7 | 8 10 6 | | 66 | 10 | 2 19 6 |
| | 32 | 7 | 2 1 0 | | 20 | 7 | 4 8 6 |
| | 25 | 1 | 2 10 6 | Bedford United ......... | 107 | 7 | 3 15 6 |
| | 21 | 6 | 6 8 6 | | 99 | 7 | 4 2 6 |
| | 18 | 10 | 2 0 6 | Holmbush ............... | 45 | 6 | 9 1 0 |
| East Caradon ... ........ | 92 | 1, 10 | 4 3 0 | | 42 | 6 | 10 5 0 |
| | 77 | 1 | 4 8 0 | | 38 | 5, 12 | 3 0 6 |
| | 72 | 6 | 4 10 6 | | 35 | 6 | 11 4 6 |
| | 70 | 6 | 4 9 6 | Wheal Friendship ...... | 83 | 5, 6 | 9 9 6 |
| | 64 | 1 | 7 6 6 | | 70 | 6, 10 | 2 13 6 |
| | 58 | 9 | 4 9 0 | Kelly Bray ............... | 70 | 3, 7, 9 | 4 0 0 |
| | 55 | 6 | 6 7 6 | | 42 | 9, 11 | 3 18 6 |
| | 15 | 1 | 10 8 6 | | 39 | 1 | 1 5 6 |
| Phœnix Mines ......... | 119 | 7 | 2 11 0 | Wheal Emma ............ | 47 | 10 | 1 18 6 |
| | 101 | 8 | 2 3 0 | | 33 | 8 | 3 9 0 |
| | 93 | 1, 7, 10 | 2 16 6 | | 27 | 6 | 5 10 6 |
| | 70 | 6 | 6 19 6 | | 26 | 12 | 0 19 0 |
| | 40 | 8 | 3 5 0 | Lady Bertha ............ | 72 | 7 | 2 17 0 |
| | 38 | 5 | 11 15 0 | Bampfylde ............... | 47 | 1, 5, 6 | 13 11 6 |
| New Wheal Martha ... | 105 | 1, 5 | 1 13 0 | New East Russell ...... | 27 | 2 | 3 14 6 |
| | 101 | 3 | 2 7 0 | Fursdon .................. | 20 | 8, 14 | 4 3 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| Devon Great Consols... | 2,404 | £10,563 14 0 | Holmbush ...................... | 160 | £1,345 11 9 |
| East Caradon ............ | 503 | 2,593 11 0 | Wheal Friendship ......... | 153 | 973 13 6 |
| Phœnix..................... | 461 | 1,848 1 6 | Kelly Bray .................. | 151 | 494 11 6 |
| New Wheal Martha ... | 433 | 986 1 6 | Wheal Emma ............... | 133 | 378 4 0 |
| Hingston Down ......... | 410 | 1,305 5 6 | Lady Bertha.................. | 72 | 205 4 0 |
| Marke Valley ............ | 402 | 1,232 7 0 | Bampfylde..................... | 47 | 638 0 6 |
| Wheal Edward............ | 222 | 771 12 6 | New East Russell........... | 27 | 100 11 6 |
| East Russell............... | 216 | 775 12 0 | Fursdon........................ | 20 | 83 0 0 |
| Bedford United ......... | 206 | 812 6 0 | | | |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Vivian and Sons ......... | 986 | £4,092 17 11 | 9 Copper Miners' Co. ...... | 389$\frac{1}{8}$ | £1,401 16 2 |
| 2 Freeman and Co. ......... | 248 | 952 10 6 | 10 Charles Lambert ......... | 603$\frac{5}{8}$ | 1,615 7 5 |
| 3 Grenfell and Sons ......... | 648$\frac{5}{8}$ | 2,712 19 5 | 11 Newton, Keates & Co.... | 145 | 571 16 0 |
| 4 Crown Copper Co.......... | — | —— | 12 Sweetland, Tuttle & Co. | 256 | 708 4 0 |
| 5 Sims, Willyams & Co. ... | 694$\frac{1}{8}$ | 3,405 19 3 | 13 Neath Copper Co. ...... | — | —— |
| 6 Williams, Foster & Co. ... | 1,074$\frac{1}{8}$ | 6,357 14 8 | 14 Penclawdd Co............. | 34 | 128 10 0 |
| 7 Mason and Elkington ... | 580$\frac{1}{8}$ | 1,891 11 8 | | | |
| 8 F. Bankart .................. | 360 | 1,268 0 0 | Total ............... | 6,920 | £25,107 7 0 |

Average Produce, 5$\frac{3}{4}$.
Quantity of Fine Copper, 349 tons 4 cwts.

Average Standard ................ £119 6 0
Average Price per ton ........... 4 3 6

# Copper Ores.

**Sampled August 5, and sold at Swansea August 25.**

| Mines. | Tons. | Produce. | Purchasers. | Price. | | |
|---|---|---|---|---|---|---|
| Berehaven | 120 | 11¾ | 7 | £9 | 11 | 0 |
| | 80 | 11⅝ | 7 | 9 | 15 | 0 |
| | 100 | 11 | 3 | 9 | 2 | 6 |
| | 75 | 10⅝ | 1 | 8 | 18 | 0 |
| | 84 | 11⅝ | 7 | 9 | 14 | 6 |
| | 69 | 11½ | 7 | 9 | 8 | 6 |
| Cobre | 94 | 12⅝ | 3 | 10 | 19 | 0 |
| | 93 | 12⅜ | 3 | 10 | 19 | 0 |
| | 83 | 12¼ | 2 | 10 | 13 | 0 |
| Knockmahon | 114 | 9¾ | 6 | 8 | 1 | 0 |
| | 48 | 11½ | 2, 14 | 9 | 7 | 0 |
| Del Soto | 62 | 23⅝ | 5 | 19 | 9 | 6 |
| | 55 | 23 | 5 | 18 | 16 | 0 |
| | 3 | 18 | 15 | 14 | 18 | 0 |
| British Regulus | 25 | 22½ | 10 | 19 | 6 | 6 |
| British Regulus | 19 | 19½ | 1 | £16 | 7 | 6 |
| | 3 | 24 | 1 | 18 | 1 | 0 |
| | 26 | 21⅝ | 10 | 17 | 10 | 6 |
| Ballycummisk | 38 | 13⅜ | 6, 15 | 11 | 5 | 0 |
| | 24 | 4 | 14 | 2 | 18 | 6 |
| Fortune (W.A.) | 34 | 22½ | 6 | 17 | 18 | 0 |
| Cape Copper | 23 | 33 | 5 | 26 | 18 | 0 |
| Kanmantoo | 17 | 46 | 6 | 38 | 19 | 0 |
| Precipitate | 1 | 56⅜ | 5 | 44 | 6 | 0 |
| Connorree | 5 | 27 | 5 | 21 | 7 | 0 |
| (Precpitate) | 2 | 10½ | 10 | 8 | 0 | 0 |
| Victoria Slag | 5 | 6½ | 5 | 4 | 0 | 0 |
| Fortune (W.A.) | 2 | 21⅝ | 15 | 18 | 6 | 0 |
| Connorree Ore | 80 | 3⅛ | 6 | 2 | 16 | 0 |
| British Regulus | 10 | 39 | 5 | 33 | 5 | 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Berehaven | 528 | £4,973 | 4 | 6 |
| Cobre | 270 | 2,931 | 12 | 0 |
| Knockmahon | 162 | 1,366 | 10 | 0 |
| Del Soto | 120 | 2,286 | 3 | 0 |
| British Regulus | 73 | 1,304 | 1 | 0 |
| Ballycummisk | 62 | 497 | 14 | 0 |
| Fortune (W.A.) | 34 | 608 | 12 | 0 |
| Cape Copper | 23 | 618 | 14 | 0 |
| Kanmantoo | 17 | £662 | 3 | 0 |
| Precipitate | 1 | 44 | 6 | 0 |
| Connorree Precipitate | 7 | 122 | 15 | 0 |
| Victoria Slag | 5 | 20 | 0 | 0 |
| Fortune (W.A.) | 2 | 36 | 12 | 0 |
| Connorree Ore | 80 | 224 | 0 | 0 |
| British Regulus | 10 | 332 | 10 | 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| 1 Copper Miners' Co. | 97 | £1,032 | 15 | 6 |
| 2 Freeman and Co. | 107 | 1,108 | 7 | 0 |
| 3 Grenfell and Sons | 287 | 2,960 | 3 | 0 |
| 4 Crown Copper Co. | — | —— | | |
| 5 Sims, Willyams, Nevill & Co. | 161 | 3,363 | 14 | 0 |
| 6 Vivians and Sons | 264 | 2,626 | 4 | 0 |
| 7 Williams, Foster & Co. | 353 | 3,393 | 4 | 6 |
| 8 British and For. Copper Co. | — | —— | | |
| 9 Mason and Elkington | — | —— | | |
| 10 Bankart and Sons | 53 | £954 | 15 | 6 |
| 11 Charles Lambert | — | —— | | |
| 12 Ravenhead Copper Co. | — | —— | | |
| 13 Sweetland, Tuttle & Co. | — | —— | | |
| 14 Jennings & Co. | 48 | 294 | 12 | 0 |
| 15 Neath Copper Co. | 24 | 295 | 1 | 0 |
| 16 Penclawdd Copper Co. | — | —— | | |
| Total | 1,394 | £16,028 | 16 | 6 |

# Black Tin Sales.

| Dates. | Mines. | Tons | c. | q. | lbs. | Price per ton £ | s. | d. | Purchasers. | Amount of Money £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug. 19. | St. Day United | 29 | 19 | 0 | 26 | — | | | — | 2549 | 13 | 2 |
| | " | 13 | 16 | 0 | 21 | — | | | — | | | |
| " 22. | Wheal Uny | 14 | 5 | 0 | 1 | 64 | 10 | 0 | — | 921 | 10 | 4 |
| | Redmoor | 5 | 0 | 0 | 0 | 68 | 5 | 0 | Bissoe Co. | 341 | 5 | 0 |
| " 27. | West Fowey Consols | 34 | 4 | 2 | 23 | 68 | 10 | 0 | — | 2468 | 18 | 7 |
| | " | 2 | 3 | 1 | 2 | 57 | 0 | 0 | — | | | |
| " 28. | Par Consols | 37 | 9 | 1 | 22 | 68 | 5 | 0 | — | 2557 | 9 | 8 |
| | Cornubia | 5 | 7 | 0 | 6 | [illegible] | 0 | 0 | Daubuz & Co. | 363 | 19 | 7 |
| Sept. 1. | West Beam | 3 | 16 | 3 | 25 | 70 | 0 | 0 | Harvey & Co. | 269 | 8 | 1 |
| " 2. | Great Wheal Busy | 25 | 12 | 1 | [illegible] | — | | | — | 1543 | 10 | 9 |
| " 3. | Prosper United | 9 | 18 | 0 | 3 | 67 | 10 | 0 | Bolitho & Sons | 750 | 8 | 0 |
| | " | 1 | [illegible]4 | 0 | 23 | 48 | 0 | 0 | ditto | | | |
| " 8. | East Wheal Lovell | [illegible] | 15 | 0 | 10 | 69 | 10 | 0 | Treriffe | 418 | 19 | 0 |
| | " | 1 | 12 | 3 | 4 | 54 | 0 | 0 | ditto | | | |
| | Garlidna United | 7 | 11 | 0 | 19 | 68 | 5 | 0 | Bissoe Co. | 606 | 2 | 0 |
| | " | 1 | 12 | 3 | 0 | 49 | 0 | 0 | ditto | | | |
| " 12. | Kitty (St. Agnes) | 20 | 2 | 2 | 20 | — | | | — | 1353 | 19 | 7 |
| " 14. | Great Wheal V[illegible] | 30 | 18 | 3 | 26 | — | | | — | 2185 | 9 | 10 |
| " 15. | North Jane [illegible]or | 2 | 6 | 3 | 8 | — | | | — | 142 | 13 | 2 |

# Copper Ores.

Sampled Aug. 19, and sold at Swansea, Sept. 8.

| Mines. | Tons. | Produce. | Purchasers. | Price. | Mines. | Tons. | Produce. | Purchasers. | Price. |
|---|---|---|---|---|---|---|---|---|---|
| Cobre | 108 | 12¼ | 3 | £10 6 0 | Berehaven | 83 | 11½ | 1, 7 | £8 16 6 |
| | 102 | 18 | 5 | 10 9 0 | | 124 | 11⅛ | 7 | 8 13 0 |
| | 62 | 23¾ | 3 | 19 5 0 | Yudanamutana | 46 | 30¼ | 15 | 24 6 0 |
| | 57 | 23¼ | 7 | 18 17 0 | | 44 | 32¼ | 2 | 25 11 0 |
| | 106 | 12⅛ | 11 | 10 7 0 | | 18 | 33¼ | 15 | 26 4 0 |
| | 105 | 12⅛ | 11 | 10 5 0 | Laxey | 148 | 6¾ | 3, 7 | 4 9 6 |
| | 90 | 12¼ | 6 | 10 7 0 | French Slag | 97 | 2¾ | 5 | 0 19 6 |
| | 98 | 12¼ | 1 | 10 6 6 | Cape Copper | 15 | 36¼ | 5 | 30 10 0 |
| | 33 | 33¼ | 14 | 26 18 6 | | 3 | 26⅛ | 11 | 21 0 0 |
| Berehaven | 126 | 9½ | 6 | 8 1 0 | Bathurst | 6 | 24¼ | 11 | 20 17 0 |
| | 76 | 10 | 15 | 8 2 0 | Knockmahon | 80 | 13¾ | 6 | 10 14 0 |
| | 65 | 10¼ | 6 | 8 3 0 | | 43 | 13¾ | 6 | 10 13 0 |
| | 63 | 10½ | 2 | 8 3 0 | French Slag | 8 | 11¼ | 5 | 7 12 0 |

TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| Cobre | 761 | £9,451 9 6 | Cape Copper | 18 | £520 10 0 |
| Berehaven | 537 | 4,474 0 6 | Bathurst | 6 | 125 2 0 |
| Yudanamutana | 108 | 2,718 12 9 | Knockmahon | 123 | 1,313 19 0 |
| Laxey | 148 | 662 6 0 | French Slag | 8 | 60 16 0 |
| French Slag | 97 | 94 11 6 | | | |

EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Copper Miners' Co. | 139½ | £1,376 0 6 | 10 Bankart and Sons | — | —— |
| 2 Freeman and Co. | 107 | 1,627 13 0 | 11 Charles Lambert | 220 | £2,361 9 0 |
| 3 P. Grenfell and Sons | 244 | 2,637 1 0 | 12 Ravenhead Copper Co. | — | —— |
| 4 Crown Copper Co. | — | —— | 13 Sweetland, Tuttle & Co. | — | —— |
| 5 Sims, Willyams, Nevill & Co. | 222 | 1,678 15 6 | 14 Jennings and Co. | 33 | 888 10 6 |
| 6 Vivian and Sons | 404 | 3,789 10 0 | 15 Neath Copper Co. | 140 | 2,205 0 0 |
| 7 Williams, Foster & Co. | 296½ | 2,842 7 3 | 16 Penclawdd Copper Co. | — | —— |
| 8 British and For. Copper Co. | — | —— | | | |
| 9 Mason and Elkington | — | —— | Total | 1,806 | £19,416 6 6 |

Sampled Sept. 2, and sold at Swansea, Sept. 22.

| Mines. | Tons. | Produce. | Purchasers. | Price. | Mines. | Tons. | Produce. | Purchasers. | Price. |
|---|---|---|---|---|---|---|---|---|---|
| Cobre | 94 | 12¼ | 6 | £10 4 0 | Knockmahon | 47 | 11⅜ | 5 | £9 4 0 |
| | 92 | 12¼ | 6, 11 | 10 2 0 | | 107 | 10 | 2, 7 | 7 17 6 |
| | 66 | 12¼ | 6 | 9 17 0 | | 99 | 13 | 5 | 10 16 0 |
| | 106 | 12¼ | 3, 11 | 9 19 0 | Kanmantoo | 14 | 56¼ | 6 | 46 17 0 |
| | 105 | 12¾ | 8 | 10 4 0 | | 12 | 58¼ | 6 | 47 17 0 |
| | 104 | 12¼ | 3 | 10 4 0 | Connorree | 42 | 3¼ | 1 | 2 12 6 |
| | 108 | 12¼ | 3 | 10 2 0 | Victoria slag | 5 | 6¾ | 5 | 3 15 0 |
| | 96 | 12¾ | 15 | 10 3 0 | Cape Copper | 64 | 37¼ | 10 | 32 1 6 |
| | 80 | 12¼ | 7 | 10 1 0 | | 31 | 32¼ | 5 | 27 15 0 |
| | 70 | 22¼ | 5, 7 | 18 18 6 | | 24 | 20¼ | 11 | 17 4 0 |
| (Precipitate) | 11 | 52¼ | 5 | 42 5 0 | | 23 | 20¼ | 14 | 17 11 0 |
| | 10 | 55¼ | 5 | 43 12 0 | | 17 | 35½ | 14 | 30 6 0 |
| | 10 | 13⅜ | 1 | 11 2 6 | | 8 | 48 | 7 | 41 15 0 |
| (Regulus) | 57 | 32 | 7 | 26 11 0 | (Ookip) | 50 | 27 | 7, 15 | 22 17 6 |
| | 43 | 31½ | 2 | 25 3 0 | | 48 | 32¼ | 14 | 27 10 0 |
| Berehaven | 102 | 10¼ | 7 | 8 5 0 | | 24 | 32¼ | 3 | 27 19 0 |
| | 86 | 11¼ | 10 | 9 9 6 | | 24 | 32 | 3 | 27 11 0 |
| | 81 | 10¼ | 1 | 8 5 6 | | 5 | 36 | 7 | 30 13 0 |
| | 67 | 9¾ | 1 | 8 1 0 | (Springbok) | 30 | 24½ | 3 | 20 15 0 |
| | 76 | 9¾ | 9 | 7 17 6 | (Koperberg) | 20 | 20½ | 3, 11 | 17 4 0 |
| | 48 | 9¼ | 1, 3 | 7 19 0 | (Odd bags) | 9 | 29 | 11 | 24 13 0 |
| | 119 | 9¼ | 10 | 8 0 0 | (Sweepings) | 2 | 28 | 2 | 23 12 3 |
| Knockmahon | 85 | 10⅜ | 7, 10 | 8 15 6 | | | | | |

TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| Cobre | 1,052 | £13,525 7 0 | Connorree | 32 | £110 5 0 |
| Berehaven | 579 | 4,798 1 6 | Victoria slag | 5 | 19 0 0 |
| Knockmahon | 338 | 3,090 2 0 | Cape Copper | 379 | 9,763 3 0 |
| Kanmantoo | 26 | 1,230 2 0 | | | |

EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Copper Miners' Co. | 224 | £1,621 18 6 | 10 Bankart and Sons | 311¼ | £4,192 11 9 |
| 2 Freeman and Co. | 98¼ | 1,549 19 3 | 11 Charles Lambert | 142 | 1,898 12 0 |
| 3 P. Grenfell and Sons | 482 | 6,067 5 0 | 12 Ravenhead | — | —— |
| 4 Crown Copper Co. | — | —— | 13 Sweetland, Tuttle & Co. | — | —— |
| 5 Sims, Willyams, Nevill & Co. | 238 | 3,943 19 6 | 14 Jennings & Co. | 88 | 2,238 1 |
| 6 Vivian and Sons | 232 | 3,303 12 0 | 15 Neath Copper Co. | 121 | 1,54 6 6 |
| 7 Williams, Foster & Co. | 408 | 5 674 12 0 | 16 Penclawdd Copper Co. | — | —— |
| 8 British and Foreign | — | —— | | | |
| 9 Mason and Elkington | 76 | 578 10 0 | Total | 2421 | £32,536 0 |

# Lead Ore Sales.

| Dates. | Mines. | Tons. | Price per Ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|
| Aug. 15. | Newtownards | 25 | 12 | 7 | 0 | Mining Co. of Ireland | 617 | 10 | 0 |
| | " | 25 | 12 | 7 | 0 | Sims, Willyams & Co. | | | |
| " 27. | Maesysafn | 100 | 12 | 16 | 6 | Walker, Parker & Co. | 1,282 | 10 | 0 |
| | Mount Pleasant | 11 | 11 | 18 | 6 | ditto | 200 | 16 | 0 |
| | " | 5 | 13 | 18 | 6 | ditto | | | |
| | Hendre Ucha | 11 | 12 | 18 | 0 | ditto | 141 | 18 | 0 |
| | Bryngwn | 7 | 13 | 0 | 6 | ditto | 231 | 13 | 6 |
| | " | 10 | 14 | 1 | 0 | A. Eyton | | | |
| | Pant-y-Mywn | 19 | 11 | 13 | 0 | Newton, Keates & Co. | 221 | 7 | 0 |
| | Maudlin | 8 | 12 | 11 | 0 | A. Eyton | 100 | 8 | 0 |
| | East Pant Du | 6 | 12 | 2 | 0 | Newton, Keates & Co. | 72 | 12 | 0 |
| | Tassan | 40 | 12 | 0 | 6 | Walker, Parker & Co. | 481 | 0 | 0 |
| | Dyliffe | 45 | 12 | 8 | 0 | ditto | 558 | 0 | 0 |
| | Roman Gravels | 25 | 12 | 12 | 6 | Newton, Keates & Co. | 315 | 12 | 6 |
| | Pant-y-Pydew | 12 | 13 | 4 | 6 | Walker, Parker & Co. | 158 | 14 | 0 |
| " 31. | East Logylas | 60 | 12 | 12 | 6 | Panther Co. | 757 | 10 | 0 |
| | Glogfach | 30 | 16 | 2 | 6 | Stock & Co. | 967 | 10 | 0 |
| | " | 30 | 16 | 2 | 6 | J. & J. Williams | | | |
| | Cwmystwith | 50 | 12 | 13 | 0 | Sims, Willyams & Co. | 1,265 | 0 | 0 |
| | " | 50 | 12 | 13 | 0 | Panther Co. | | | |
| Sept. 2. | Dyliffe | 40 | 12 | 16 | 6 | Newton, Keates & Co. | 513 | 0 | 0 |
| | Llanerchyraur | 20 | 13 | 6 | 6 | ditto | 266 | 10 | 0 |
| " 3. | Wheal Frank Mills | 45 | 14 | 9 | 0 | Sims, Willyams & Co. | 1,726 | 12 | 6 |
| | " | 95 | 11 | 4 | 6 | Treffry's Trustees | | | |
| " 4. | Minera | 110 | 13 | 9 | 0 | Sims, Willyams & Co. | 7,130 | 8 | 0 |
| | " | 110 | 13 | 4 | 0 | Walker, Parker & Co. | | | |
| | " | 110 | 13 | 4 | 0 | ditto | | | |
| | " | 100 | 13 | 6 | 0 | Sims, Willyams & Co. | | | |
| | " | 97 | 13 | 4 | 0 | Walker, Parker & Co. | | | |
| | " | 4½ | 10 | 10 | 0 | ditto | | | |
| | " | 4½ | 10 | 10 | 0 | Newton, Keates & Co. | | | |
| | " | 4½ | 10 | 10 | 0 | Panther Co. | | | |
| " 5. | Wheal Mary Ann | 46 | 25 | 15 | 0 | Stock and Co. | 1,456 | 0 | 0 |
| | " | 20 | 13 | 11 | 6 | J. & J. Williams | | | |
| " 8. | Foxdale | 100 | 22 | 10 | 0 | Stock & Co. | 2,250 | 0 | 0 |
| | Wheal Ludcott and Wrey | 50 | 17 | 12 | 6 | J. & J. Williams | 881 | 5 | 0 |
| | Minera Union | 15 | 12 | 13 | 0 | Sims, Willyams & Co. | 189 | 15 | 0 |
| " 10. | Talargoch (Maesyrerwddu) | 21 | 13 | 12 | 0 | A. Eyton | 571 | 4 | 0 |
| | " | 21 | 13 | 12 | 0 | Newton, Keates & Co. | | | |
| | " (Coetia Llys) | 97 | 14 | 12 | 6 | Walker, Parker & Co. | 1,418 | 12 | 6 |
| | Deep Level | 10 | 12 | 18 | 6 | ditto | 129 | 5 | 0 |
| | Brynford Hall | 10 | 12 | 7 | 0 | Newton, Keates & Co. | 123 | 10 | 0 |
| | Rhosesmor | 100 | 13 | 5 | 6 | Walker, Parker & Co. | 1,857 | 10 | 0 |
| | " | 40 | 13 | 5 | 0 | Newton, Keates & Co. | | | |
| | Parry's | 31 | 13 | 8 | 6 | Walker, Parker & Co. | 416 | 3 | 6 |
| | Bryn Gwiog | 50 | 13 | 16 | 0 | A. Eyton | 690 | 0 | 0 |
| | Long Rake | 25 | 13 | 6 | 0 | ditto | 332 | 10 | 0 |
| | Speedwell | 15 | 12 | 9 | 6 | Walker, Parker & Co. | 187 | 2 | 6 |
| | Kilmorey | 12 | 12 | 19 | 6 | A. Eyton | 155 | 14 | 0 |
| | Pool Park | 45 | 13 | 13 | 6 | Walker, Parker & Co. | 744 | 7 | 6 |
| | " | 10 | 12 | 18 | 0 | Newton, Keates & Co. | | | |
| | Dyliffe | 36 | 13 | 4 | 0 | A. Eyton | 475 | 4 | 0 |
| | Dyfngwm | 25 | 12 | 17 | 0 | Newton, Keates & Co. | 321 | 0 | 0 |
| | Llangynog United | 58 | 12 | 12 | 6 | ditto | 732 | 5 | 0 |
| | Llanerchyraur | 15 | 13 | 5 | 0 | ditto | 198 | 15 | 0 |
| | Isle of Man Mining Co. | 90 | 14 | 11 | 6 | J. & J. Williams | 1,311 | 15 | 0 |
| " 11. | Cargoll | 68 | 16 | 3 | 0 | Panther Co. | 1,098 | 4 | 0 |
| " 12. | Harwood | 10 | 12 | 12 | 6 | Cookson & Co. | 126 | 5 | 0 |
| " 14. | Frongoch | 80 | 12 | 13 | 6 | Panther Co. | 1,014 | 0 | 0 |
| | Cefn Brwyno | 20 | 12 | 12 | 6 | ditto | 505 | 0 | 0 |
| | " | 20 | 12 | 12 | 6 | Walker, Parker & Co. | | | |
| | East Darren | 75 | 15 | 19 | 6 | Mining Co. of Ireland | 1,198 | 2 | 6 |
| | Cwm Erfin | 25 | 16 | 1 | 6 | Panther Co. | 967 | 2 | 6 |
| | " | 35 | 16 | 3 | 0 | ditto | | | |
| " 15. | West Chiverton | 70 | 18 | 15 | 6 | Stock & Co. | 1,679 | 10 | 0 |
| | " | 60 | 12 | 3 | 6 | Walker, Parker & Co. | | | |
| " 16. | Great Laxey | 100 | 18 | 4 | 6 | Mining Co. of Ireland | 1,822 | 10 | 0 |

THE

# MINING AND SMELTING MAGAZINE.

NOVEMBER, 1863.

## The Waste of Coal.

By Professor D. T. Ansted, M.A., F.R.S., &c.

A few remarks in Sir William Armstrong's recent address to the members of the British Association assembled at Newcastle have directed attention to a very important question connected with that valuable source of wealth and power contained in the various coal-fields of Great Britain. It is generally admitted that, with reasonable care, and assuming the extent of development of mining resources and application of machinery we are fairly entitled to assume, there is practically no danger of the rapid and sudden failure of our coal. But it is equally certain that, if the total quantity annually raised and accounted for continues to increase at the present rate for several years longer, many of our great manufactures must, within a calculable time at least, shift their station, and changes must take place the contemplation of which is not pleasant to those now largely interested in the northern manufacturing towns. No doubt all change will be gradual, but so many parts of the old northern coal-fields of England are already showing signs of approaching exhaustion that our friends there are slightly nervous on the subject, and are not fond of having it even discussed.

But it is not so much the natural and proper use of coal that it is my object to discuss in the present article. It is to the improper and unnecessary destruction of this great wealth—the waste of whole beds of coal not worked—the waste of large parts of beds that are worked—the waste of large quantities of what is not only extracted, but part of which is daily brought to the pit mouth and left there to rot—as well as the great waste of coal used as fuel for want of chemical knowledge and from the neglect of reasonable precautions in the construction of chimnies and furnaces:—it is to these that I now desire to attract the attention of my readers. The latter

cause of waste was referred to by Sir William Armstrong, and does not strictly belong to our subject; but there can be no doubt that the clouds of unconsumed fuel that thicken our atmosphere and render English towns so dirty are as much a discredit to the ingenuity of Englishmen as it would be if our farmers used sugar as a manure, or if we were in the habit of employing beer instead of water to turn our mill-wheels.

I have named three distinct sources of waste of coal, and all who are familiar with coal mining must be aware that each of these three involves serious loss and a crying evil. I believe that each might be remedied, and, objectionable as restrictive laws always are in industrial occupations, it really seems as if the only means of checking this constant mischief is to be sought in some act of the Legislature.

The first waste is that of whole beds of coal. It is by no means unusual in some mining districts, if there happen to be two or three tolerable seams overlying one better seam, to sacrifice the former because the latter obtains a higher price and pays better for working. Wherever this is done the overlying beds are destroyed, for after the lower coal is exhausted the upper strata must come down irregularly, and any such matters as two-foot or yard seams of coal, already perhaps tender and not very good, are crushed and rendered utterly useless. Even when the circumstances are most favourable, as where there is an excellent stone roof and a good tough floor, the crush and corresponding creep affect all the beds to the surface, and produce cracks everywhere, admitting both water and gas, and any attempt to work these upper beds, when the lower ones are gone, is almost sure to end in failure. Perhaps after many centuries and exposure to various influences the coal may be reconsolidated, but this is a doubtful and a distant provision, whereas, if all the workable beds were always taken in regular order from above downwards, nothing of this kind could happen.

It is clear that, notwithstanding the total destruction of all this coal, it may be that the advantage of removing the valuable seam immediately is so great both to the landlord and miner that both agree to the loss; but it ought not to be forgotten that mining property under the surface, like the land itself, really belongs to the community, and is held for use, not for destruction. Any absolute destruction of that which belongs to all the inhabitants of a country for all time should not be permitted, and here therefore it would seem that restrictive laws might fairly be enacted to prevent the incidental waste of coal that may hereafter, if not at present, be worked profitably.

The second waste alluded to is that of not removing important parts of a seam, generally a thick seam, because it is found cheaper to sacrifice a foot of coal at the roof, and perhaps another foot on the floor, rather than go to the expense of holding up a bad roof. So also it is found advisable sometimes to leave large pillars of coal to be crushed to powder, rather than use the heavy timbering or construct the stone walls that would be needed to prevent it. In some cases nearly, or quite, one half a valuable seam is thus sacrificed. The time will come when all parties will regret this waste, but meanwhile I suggest whether it ought not to be checked by law. It is

rarely—perhaps never—necessary, and it would be wiser to wait till it is worth the expense to mine it properly and get nearly the whole, than thus sacrifice half in order to save a trifle in getting the other half. At any rate if this would not be convenient to the present landlord it would be just to his successors, and I suggest that to prevent so mischievous a destruction of public property interference is desirable and justifiable.

The systems of working coal vary extremely in the various districts. In some they are well-imagined and involve as little waste as possible: in many however they are designed and carried out by men of no general knowledge, no education, and no knowledge of the special conditions under which coal exists in the earth. They merely carry on the methods they have learnt as boys by a rough rule of thumb, improving nothing, modifying nothing, and caring for nothing but an immediate return sufficient to pay them. Surely these are not the men on whom the management of so important a part of our national wealth should be allowed to depend. These are not the men to whom the laying out a new mine should be intrusted; for much judgment is needed for this purpose if waste is to be prevented.

The third waste alluded to is that of small coal or dust, left either underground or at the pit mouth, and regarded as of no account. All, or at least a large part, of this is capable of use with the exercise of a little ingenuity. In some countries it is all utilised: in England it is all neglected. The quantity thus wasted where the coal is tender is exceedingly large, but cannot readily be estimated. It is waste in the strictest sense of the word—unnecessary and undesirable—and occasionally it is even burnt to get rid of it. By washing and making up with fire-clay into balls all this might be valuable fuel and save other coal.

Coal is not like the vegetable soil of a country. We cannot by any system of manuring return to the various strata the carbon in a state fit to form beds of coal that will serve our posterity. Once used it is done for, and we must seek other sources of supply, or use other means to obtain heat. This is a very serious reflection, and one that ought to induce those fortunate enough to possess coal property to submit to regulations by which their property will be made most profitable in the long run to their country and themselves. It is to be hoped that this great subject will be attended to, so that a discussion may be raised on it that may terminate in the introduction of some useful measure of legislation. All honest and well-meaning proprietors and miners would agree, if they could be induced to consider the matter fairly, that their own immediate interests are concerned in this, and that the future prospects of their mines and the very existence of their property really depend upon it.

I have carefully avoided any allusion to particular districts. The subject is familiar enough to all who have anything to do with coal-mining, and abundant examples of every kind of waste will suggest themselves but too readily. I do not wish to excite any ill-will or opposition by putting forward a definite scheme, but rather to present the subject to my readers as one on which they ought

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seriously to ponder. The mining interests in England are so large, and they, as well as the manufacturing interests, are so dependent on coal, that I am sure my readers will feel an interest in every thing connected with the future prospects of our coal-fields.

## Lead Smelting in Carinthia.

By F. Thum.*

(*Concluded from page* 144.)

As regards the operation of Smelting proper, this depends, as we know, on the partial change of the galena into sub-sulphide of lead and sulphate of lead, which, alternately re-acting on each other and on those portions of the galena remaining undecomposed, give rise to the formation of sulphurous acid, metallic lead, and oxide of lead. The latter is principally present towards the end of the process, and is reduced by the addition of carbonaceous matter.

The practical working of the process is essentially the same all throughout the district, and may be divided into the three stages of *Roasting*, *Stirring*, and *Pressing*. At all the works the writer visited, with the exception of Raibl, the charge of galena—which is ground fine—did not exceed 3½ Vienna centners, for a twelve hours' working; at the Raibl works 7½ centners were charged for a twenty-four hours' working. At others, for example, at most of the Deutsch-Bleiberg works, the charge was similarly 3½ centners; but the usual course of the process was here interrupted after about nine hours' working (before the commencement of the third stage), by a new charge being put into the furnace—which, after a like treatment of nine hours, is added to the former one, and both worked together. As to the minor modifications of the process, which may often be observed at the same works—and which principally depend on the nature of the matters accompanying the ores, and their state of decomposition—they almost entirely disappear with the Roasting stage, which is essentially the same under all adopted modifications.

Before charging the ore to the furnace the latter is allowed to cool more or less—generally to a low-red heat; after which the workman is exclusively guided, in the management of the charge, according as the admixtures of foreign sulphides with the ore require it to be roasted slowly or rapidly. This roasting begins as soon as the ore, charged through the working door, has been spread equally over the bed of the furnace by means of an iron rabble. When the charge consists of but 3½ centners, as is usually the case, only the hinder part of the bed, opposite the firebridge, is covered with it; and the duty of the workman then is to facilitate the operation by frequent

* From the *Berg- und Hüttenmännische Zeitung*. No. 23, 1863.

stirrings—generally every quarter of an hour. If the ore is very pure, the charge only requires to be ignited once to get up, from the combustion of the sulphur, a sufficient degree of heat for the completion of the roasting, and the consumption of fuel is proportionately reduced; but in this case, the charge must be only moderately stirred. In general, an imperfect stirring lengthens the process, and induces a melting of that portion of the ore subject to a high temperature—a result which should be carefully avoided, inasmuch as, in proportion as the particles of ore become enveloped with melted matter, the progress of the operation becomes necessarily interrupted. Nevertheless, too frequent stirrings, particularly with very pure ore, also interrupt the operation, since they give rise, particularly if the temperature is not kept sufficiently low, to too active a reaction, which results in a swelling up, showing a partial melting of the mass. If, as is frequently the case—particularly at Deutsch-Bleiberg and Raibl—the galena contains blende, the roasting stage requires more frequent stirrings, as well as an increased expenditure of fuel—since the blende is less easily oxidised. In general, three hours are required for roasting 3½ centners of ore, during which period, at the Bleiberg works, from five to six logs of wood (about 2 cubic feet) are consumed. If the ores are very pure, or are already partially decomposed, the time is considerably shortened. Thus, for example, at the Windisch-Bleiberg works, near Klagenfurt, where the ores are obtained from long-abandoned workings recently resumed, only one hour is required for roasting 3½ centners of ore.

The sufficient completion of the roasting is shown by the disappearance of the sulphur fumes (which before were clearly perceivable on the stirring of the charge), as well as by the appearance of lead drops trickling down the front of the inclined bed of the furnace: after the conclusion of the roasting also, the mass (which before moved rather with the appearance of a fluid) moves like dry sand. With the running out of the lead over the hollowed cast-iron plate in the working door, commences the second stage of the operation—that of "Stirring."

At the commencement of this stage the temperature of the furnace is raised by large additions of fuel, at which temperature it is maintained until the end of it. The workman has to continue stirring the charge every quarter or half hour, so that the various portions may be brought to react on each other at an equally high temperature. If the separation of the metal should slacken, the temperature is again raised, until at last all reaction entirely ceases, and the so-called "Stirring" process is brought to a conclusion. With a charge of 3½ centners, this operation usually requires from five to six hours, and furnishes, with an average consumption of from sixteen to eighteen logs of wood (about 6 cubic feet), somewhat over half the whole of the metal produced.

After the conclusion of this stage, the addition of fuel ceases for a short time; when the workman—after repeated stirring—gathers the charge into a heap in the furnace, covers it with several shovelsfull of red-hot carbonaceous matter from the fire-place, and mixes the whole together; after which the temperature is again raised as high as possible by renewed additions of fuel, and the so-called "Pressing"

stage commences. This principally consists in working the charge well up together at the highest possible steady temperature, at the same time repeating the addition of carbonaceous matter, until, within about three hours (with a charge of 3½ centners), the remainder of the lead runs off through the working door. The expenditure of fuel during the three hours of the continuance of this stage is nearly double that consumed for the preceding stages; and at Bleiberg therefore it is estimated to average 11 cubic feet of wood.

In the regular course of the whole twelve hours' working, if the percentage of lead in the galena treated ranges from 65 to 70 %, from 60 to 65 % of the metal is, on an average, extracted, with a consumption of about 10 cubic feet of wood per centner of lead. This shows a loss of 5 % of metal (which sometimes even reaches 7 %), of which perhaps one-half is found in the residues that remain in the furnace at the end of the last stage; these are collected, and the lead they contain extracted by washing, which lead is subsequently treated in the same furnace with the lead slags.

As has been already remarked, this process only varies at the different works in the charge being withdrawn from the furnace at the end of the second stage, and a new one put in which is allowed to pass through the two first stages; after which both are treated together with charcoal, and subjected to the last process of "Pressing." This only alters the process by extending the time required for the last stage from three to from five to six hours; and as it results that only 7 centners can thus be treated in twenty-four hours, there seems no considerable advantage in this modification of the process—except, perhaps, that the workman is able to give a greater supervision, inasmuch as the important stages of Roasting can both be effected in the daytime.

The process adopted at Raibl, with a charge of 7½ centners, is similar to the preceding, except that the corresponding stages require a longer time. As the dimensions of the furnaces are much the same as those at Bleiberg and other places, it is necessary, at the beginning of the process, to spread out these larger charges not only over the back part of the furnace, but also over the whole bed, in order to afford the greatest possible surface for the roasting. After an hour, during which the charge has been stirred every fifteen minutes, about ¼ cubic foot of fuel is supplied, and this is renewed (the stirring being continued) as the fire has burnt down, for perhaps three hours. Two hours after charging, the ore attains nearly a white heat, and maintains this temperature (after a firing that has lasted about three hours) with scarcely any further fuel, during the remaining four or five hours necessary for the completion of the roasting.

The whole Roasting stage thus lasts about eight hours. When the separation of the lead commences fresh fuel is added, and the temperature is kept as high as possible during the following seven hours—that is during the "Stirring" stage. When the lead has ceased to run, the temperature is allowed to fall for perhaps half-an-hour, while the charge is vigorously stirred to complete the roasting; after which carbonaceous matter is thrown amongst it, and the tem-ture again raised as high as possible during the six or seven

hours of the "Pressing" stage. In these twenty-one to twenty-two hours 7½ centners of ore are treated, with results as satisfactory as those attained at Bleiberg and other places. As in the process already described, three smelters are employed at each furnace during the twenty-four hours, who relieve each other every eight hours.

The process at Raibl has evidently this advantage over the one previously described, that ½ centner more ore can be treated in less time. The labour is however harder, and this is the reason why the smaller charge is still retained at Deutsch-Bleiberg, the true centre of the Carinthian lead industry, where the workmen are sufficiently numerous to successfully oppose innovation.

An attempt was made some time ago, at Bleiberg and Raibl, to introduce double-bedded reverberatory furnaces, with the object of applying the flames passing off during the two latter stages at the same time to roasting, in order thus to increase the quantity daily treated. The attempt, however, was unsuccessful, owing to the difficulties that arose, as might be expected, in regulating the fire. At all events the single furnaces have long since been resumed; and indeed, in spite of their proportionately small power of production, compared with other reverberatory-furnace processes, it is admitted that they smelt advantageously, and above all are recommended by their cheapness—for a furnace and stack can be erected for about 170 thalers.*

The cost of smelting the Carinthian lead ores depends very much upon the greater or less number of furnaces a smelter has in work—for those who do not (as is frequently the case) work even one furnace continuously are evidently at a disadvantage compared with the larger smelters; however, from what has gone before, we can form an idea of the advantages to be obtained by the Carinthian process. If we estimate the principal items of cost, calculating the average price of a cord of wood (90 cubic feet), including carriage, at 10 florins (about 1*l.* sterling), the total cost of smelting a charge of 7 centners of ore of an average produce of 60 %, and yielding 4·2 centners of lead—taking the consumption of fuel at 38 cubic feet of wood, costing 4 florins 22 kreuzers, and including labour and maintenance of furnace—is 8 florins 72 kreuzers, or 2 florins 8 kreuzers per centner of lead produced. If we assume the combustibility of a cubic foot of wood to equal 13·2 lbs. of good coal, and estimating the cost of 1 centner of the latter at 28½ kreuzers, the above amount would be considerably lessened, for, in that case, the fuel required for the production of 4·2 centners of lead, instead of costing 4 florins 72 kreuzers, would only cost 1 florin 43 kreuzers.

A comparison between the various methods of smelting lead ore by the aid of a blast and operations in reverberatory furnaces shows a result favourable to the latter—which, by only leaving trifling residues, is unattended with any costly minor processes. The Carinthian process is evidently inferior to the English and French reverberatory-furnace processes, on account of the disproportionately smaller production obtained with it: for, while 30 or more centners

* About £25 sterling.—Ed. M. & S. M.

of ore can be smelted at one time in an English or French furnace, in Carinthia only 7 centners can be successfully treated. This disadvantage, combined with a relatively greater consumption of fuel and labour, prices being equal in other respects, is not compensated for by the cheapness of the Carinthian furnaces, and by the total avoidance of any special treatment of the residues, which is necessary in both the other processes. The Carinthian process, however, is always preferable when, with very cheap fuel, the aim is to obtain a comparatively small production from very pure galena.

## Description of the Mining District of Massa Marittima, Tuscany.

### CAPANNE VECCHIE MINE.

By Nelson Boyd, Mining Engineer.

The copper veins of Tuscany are found to exist in two distinct geological formations—firstly, in connection with the serpentine and Gabbro Rosso; secondly, in the limestones of the Tertiary formation so abundant in Italy. Those discovered in the former formation partake more of the character of deposits than lodes or veins, and their working presents some uncertainty. They are, however, extremely important, and their extraction is, in some instances, attended with great profit, as the workings of the prosperous mine of Monte Catini testify. On the other hand, the ores found in the Tertiary formation present features of great regularity, and, although they are not so rich, the facility with which they can be worked amply compensates for the lower percentage.

In the mining district of Massa Marittima numerous and powerful lodes of this description are known to exist; their general course being north and south, and the dip about 42° east. These veins have been worked in times of remote antiquity. At Serra Bottino, three miles south of the town of Massa Marittima, no less than 250 old shafts have been found, some of which have a depth of 200 yards.

The commencement of these workings is supposed to date from the time of the Etruscans, who are known to have worked both silver and copper in the neighbourhood. However, the date of the first record of the mines of Massa is 1225, and at that time mining appears to have been in a flourishing state in the district and to have continued so for about a century. But the war with the Sienese in 1330, and the terrible pest of 1348, put a stop to all enterprise in the Marrema, and these mines, as well as others, were abandoned and not reopened until quite recently. Within the last thirty years or so, mining in Tuscany has received considerable impulse, and numerous new trials have been made, especially in the Marrema. In the Massa district several mines have been opened on veins anciently worked as well as on new discoveries.

The speculations, however, have not been attended with much success; but the cause of their failure must be attributed, more to the want of experience in mining matters of the early promoters, the absence of experienced miners, and the want of skilled labour, than to the poverty of the veins or the difficulty of working them.

The want of men of experience was soon felt in a country where mining

had for centuries been abandoned, and foreigners had to be called in to supply the deficiency. These, although well acquainted with the principles of mining, and the peculiarities of their own country, were ignorant of the characteristics of this new field, and were therefore at first unable to direct operations in the most advantageous manner.

The district was sparingly inhabited, and beyond the main postal roads there existed no means of communication whatever; and in addition to all these drawbacks, the unhealthy state of the atmosphere during the summer months became a formidable impediment to the opening of new works.

However, in spite of all these difficulties numerous shafts have been sunk and adit levels driven on different veins, and three smelting works erected—one at the Capanne Vecchie, one at the Accesa, and another at Castelaccia. At present none of the latter are in activity, and only one mine, the Capanne Vecchie, is producing ore.

This mine is situated about four miles to the south of Massa Marittima, and may be taken as an example of the general character of the district. The ores are found in regular stratified deposits, composed of a matrix of quartz containing the ore disseminated through its mass. These deposits have a great width, not only at surface but also in depth, varying in the mine from six to ten yards, and measuring at surface as much as 20 yards. The ore consists of yellow copper pyrites, containing a large proportion of sulphuret of iron. The highest percentage of copper is about 25°/₀, but the average is below 10°/₀.

There is also a certain proportion of grey ore, which in places appears decomposed, and is raised from the mine in the state of dust containing from 8 to 12°/₀ of copper.

At the Capanne Vecchie mine, the underground workings consist of an adit level 32 yards below the surface at the main shaft, and three shafts used for drawing the stuff. The depth is inconsiderable, nevertheless a sufficient quantity of copper ore is raised from the vein to pay expenses and yield a profit.

At present, operations are restricted to driving forward the adit level on the vein, and working the ore to the rise, on the principle of the German Fürstenbau. As the ore is taken out, the open space is filled up with stone and rubbish, built up like walls and kept close to the face. The height of vein thus excavated is as much as 8 yards in places, and in some cases the yield per fathom forward amounts to 10 tons, but the average is not more than from 3 to 4 tons per fathom, containing 10°/₀ of metal, and not including the poorer ores.

When raised to surface the ore is sorted into two qualities. The first, containing 10 to 12°/₀, is exported direct to England; the second, containing under 5°/₀, is stacked in large heaps awaiting some process by means of which it may be profitably reduced. The quantity of the former quality raised is about 90 tons a month, during the working season. I was not able to ascertain the quantity of the poorer ores, but should think it equal to, if not greater than, that of the richer ores. The existence of water below the adit level prevents the company working the vein to a greater depth without the application of pumping machinery.

So far only one vein has been worked, although seven are known to cross the sett. They have all the same direction, and several have been partially worked in the neighbouring mine of Accesa, now at a stand-still from causes foreign to mining operations.

At the Capanne it had been originally intended to smelt the ore, and for that purpose furnaces, and all other necessary adjuncts, were erected. But, owing principally to the high price of fuel, the plan did not succeed and had to be abandoned, and the ores brought into the market. It was found that ore containing less than 10 °/₀ would not bear the cost of carriage, and as, owing to the difficulty of separating the iron pyrites from

the copper, a large proportion of poor ores remained on hand, it was determined to adopt for these, if possible, some chemical process of reduction. Many different methods were tried, but the one eventually adopted is substantially as follows:—

The poor ores, containing from 2½ to 4 °/₀ of copper, and a considerable proportion of iron pyrites, are piled in large heaps in the open air on faggots properly arranged. These are lighted, and the ore thus roasted and deprived of a large proportion of sulphur, and also rendered more friable. The roasted ore is then ground, and mixed with a proportion of common salt equal to twice the percentage of copper contained in it. The mixture is then introduced into a reverberatory furnace, and heated until fumes of chloride of copper are perceived: this indicates the termination of the operation, which lasts about ten minutes.

The hot mass is then taken out of the furnace and deposited in tanks, and washed with water acidulated with sulphuric acid. The solution is afterwards run into vats, where it remains for a short time before the copper is precipitated. It was at first attempted to precipitate the copper in the state of oxide by means of lime, and reduce it in a furnace, thus obviating the cost of iron. This process, however, had several objections, which became evident in course of practice.

In the first place the precipitation took a considerable time, and the precipitate, composed of hydrated oxide of copper mixed with a large excess of lime, retained a certain proportion of chloride of copper, which, being extremely volatile, was lost in the process of reduction. Then again the proportion of copper contained in the precipitate was small compared with the quantity of lime used for decomposition, and a loss was sustained in the operation of smelting.

At present, however, no process whatever is adopted, and all ores below 10°/₀ of copper are put on one side.

# British Association for the Advancement of Science.

(*Concluded from page 223.*)

## CHEMICAL MANUFACTURES OF THE TYNE.

THE following is an abstract of Messrs. Stevenson, Clapham, and Richardson's paper on this important subject:—

SALT.—Salt works were formerly very numerous in this district, establishments having been formed at Howdon Pans, Hartley Pans, Jarrow, North and South Shields, and other localities. Shields salt was the most celebrated salt in the kingdom, and was produced in such quantities at South Shields as to give a character and even a nomenclature to that town, which to this day is divided into East Pan and West Pan Wards. The production of salt from sea water in this locality has given place to that obtained from the brine springs and rock salt of Cheshire. A considerable quantity of white salt is still made on the Tyne from sea water, in which rock salt from Cheshire and Ireland is dissolved in order to diminish the cost of evaporation. Two improvements have been successfully introduced in making white salt, which have the saving of fuel as their object. Mr. Wilkinson employs the waste heat of coke ovens for this purpose; and Mr. Fryar dries whitening with the heat which escapes from his salt pans.

ALKALI.—Mr. Losh and Mr. Doubleday were engaged with a series of experiments on the best plan of converting common salt into carbonate of soda. Each appears to have used very similar processes. The first plan

tried was to effect the decomposition of common salt by means of oxide of lead, and to carbonate the caustic soda, while the insoluble chloride of lead was heated to form a yellow pigment, long known as Turner's yellow. Another process consisted in decomposing common salt by sulphate of iron; the resulting sulphate of soda was fluxed with coal, and the sulphide of sodium which was formed was carbonated with sawdust. This plan was also worked some time afterwards at an alkali manufactory situated near Blyth. Another process tried was founded on the neutral decomposition of common salt and sulphate of potash. Another plan, adopted to avoid the duty, was to add ground coke or ashes to the concentrating salt pan before the salt was formed, and use it in this damaged condition for the manufacture of sulphate of soda. Messrs. Doubleday and Easterby, in 1808, commenced making sulphate of soda by decomposing the waste salts from the soap boilers. At first they purchased their sulphuric acid, but between 1809 and 1810 they got the plans of chambers from Messrs. Tennants, of Glasgow, and erected the first chamber on the Tyne at Bill Quay. They imported the first cargo of sulphur from Sicily about the same time, and its arrival in the river excited great attention. At first, the Government returned them the import duty on the sulphur, which was used in making acid, and the present Mr. Doubleday remembers having received at the end of the year as much as 1,500*l*. This, however, only lasted some three or four years, when the duty was repealed. The following details will embrace a brief account of the source of the raw materials, and the various improvements which have been recently introduced.

Source of Sulphur.—Until within the last few years Sicilian sulphur was almost exclusively employed in this district for the manufacture of sulphuric acid—the pyrites from Wicklow being the only other source of supply. This latter, however, was not sufficiently abundant to render the manufacturer independent of the great fluctuations which have recently taken place in sulphur, on account of the demand consequent on the vine disease. During the last few years the following additional sources of supply have become available:—1st, Belgian; 2nd, Norwegian; 3rd, Spanish or Portuguese; 4th, Italian; 5th, Westphalian pyrites. 1. The Belgian pyrites has the advantage of being shipped from Antwerp at a moderate freight to the Tyne. It is a very hard, compact material, containing about 50 °/$_0$ of sulphur, and therefore nearly approaches a pure bi-sulphuret of iron. The burnt residue from one manufactory on the Tyne, after being roasted in a lime-kiln to burn off the small remaining portion of sulphur, is regularly used as an iron ore. It contains no copper, and from 3 to 5 °/$_0$ of arsenic. 2. The Norwegian pyrites is shipped at Levanger. It contains 44 °/$_0$ of sulphur, is easily broken, and does not readily flux in the kiln. The quantity of copper it contains, being less than 10 °/$_0$, the burnt residue cannot be profitably smelted for copper. 3. The most extensively used pyrites is shipped from Huelva in Spain, and Pomeron in Portugal. In 1860, several cargoes of an ore containing free sulphur embedded in gypsum, were imported from the island of Milo. From the small quantity of sulphur contained in it (19 up to 24°/$_0$), there was great difficulty found in burning it, except the large masses. Still more recently, Prof. Ansted* has discovered a deposit of free sulphur in Corfu, of which he has been kind enough to forward a sample, but we believe it has not been used in commerce. When sulphuric acid is wanted quite free from arsenic, Sicilian sulphur must be used.

Caustic Soda.—This manufacture is as yet quite in its infancy in this district. In Lancashire, very large quantities are made from the "red liquors" which drain from the soda salts. These liquors always contain caustic soda, sulphuret of sodium, and common salt. In Lancashire, where

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* See *Minining and Smelting Magazine*, vol. iv, p. 99.

a hard limestone is used for belling, the percentage of caustic soda is large, while the sulphuret exists in small proportion, and it is easily oxidised. It would seem that the London chalk which is used here produces a lime, chemically much less energetic, forming less caustic soda, and holding sulphur more loosely in combination. Consequently the Tyne red liquors require a very large quantity of nitrate for their oxidation, and yield so little caustic that this process has been abandoned in favour of the well-known method of boiling a weak solution of alkali with lime. This has the advantage, however, of producing a richer and very pure article.

HYPOSULPHATE OF SODA.—The manufacture of hyposulphate of soda has largely increased of late years, and we believe in 1838 it was not made at all upon the Tyne: in 1854 the produce only amounted to 50 tons a-year, but it has gradually risen to 400 tons per annum.

HYDROCHLORIC ACID.—In the decomposition of common salt vast quantities of hydrochloric acid are necessarily produced, and it is an important question for chemical manufacturers to apply the best means for its condensation. The methods generally adopted in condensing are well known, and we shall only allude to some of the improvements practically applied. The drying furnace usually used is what is called an "open furnace," to which the heat of the fire is directly applied, and we believe that the greatest difficulties in the way of a perfect condensation in former times arose with the gases from this furnace. In former years also, the draught through the condensers was always obtained by a connection with a high chimney, but in some works this plan is now abandoned, and the whole of the gas which escapes passes through a 12" pipe always open to view. At present, these gases are conducted through long flues and cooling shafts, and on entering the foot of the condensers the heat is reduced to about 140° Fahr., at which point the gases easily condense, and a strong acid is at the same time obtained. A patent was obtained in 1860 for the use of the weak acids in the place of water in condensing, which has been successfully carried out. Muriatic acid is not entirely free from impurities, and on account of its containing arsenic, iron, sulphuric acid, &c., it is not applicable to all purposes. The total quantity of hydrochloric acid produced is about 180,000 tons per annum.

MANGANESE.—Manganese is imported from Germany and Spain; but it is chiefly from the latter country that the richest ores are now obtained, and which are found in hills consisting of schistose rock. The quality of the ore varies from 50 to 90°/₀. The richest are obtained at Calenas, in the province of Huelva. Manganese ore frequently contains peroxide of iron, copper, cobalt, titanium, &c., but no means have hitherto been taken to separate them. Manganese is used in the manufacture of glass, iron, and bleaching powder; and for the latter it is imported to the extent of 14,400 tons annually. Several patents have been taken out for the recovery of manganese from the waste chloride of manganese solutions, but generally with indifferent success. The most successful, however, is the process of the late Mr. Dunlop, of Glasgow, in which the manganese is precipitated as a carbonate, and finally oxidised. This patent has, we believe, been successfully worked at St. Rollo, in Glasgow, and has, to some extent, superseded the use of native manganese.

FRENCH LIMESTONE, LOCALLY CALLED CLIFF, is imported as ballast from the Seine, and also from the coast of France, to the extent of about 14,000 tons annually. It is always used in this locality in preference to other limestones in making bleaching powder.

ALUM.—The first alum works established in England were erected at Guisbro' in 1460. The process is well known, but potash alum (formerly the only alum made) is now produced at the Loftus Works, all the other manufactories employing the cheaper sulphate of ammonia. From the mother liquors large quantities of an impure sulphate of magnesia are

obtained, which are partly refined, and partly consumed as a manure, mixed with other substances. Alum and sulphate of alumina are also made from sulphuric acid and clay, or shale, but not to any extent. The quantity produced annually is 4,000 tons. Some improvements in the details have been introduced to economise labour and save materials. The precipitation of the iron from aluminous liquors by means of prussiate of iron, was first employed here by Messrs. Lee and Co., and the Guisbro' Alum Company have introduced an aluminous cake, containing sulphate of magnesia, which has been found to answer very well in dying certain colours, and in the manufacture of all kinds of coarse paper.

Carbonate of Magnesia.—This compound has long been produced in this district. The old process has been largely superseded by that of the late Mr. H. L. Pattinson, which consists in submitting calcined magnesian limestone to the action of carbonic acid and water, under pressure. The magnesia dissolves out as bi-carbonate of magnesia, from which the neutral carbonate of magnesia is precipitated by the application of heat. The quantity manufactured is said to be about 250 tons per annum.

Superphosphate of Lime.—The manufacture of this article was commenced at Blaydon in 1844. Various materials are employed as the source of phosphate of lime, viz., bones, bone ashes from South America, exhausted animal charcoal from the sugar refineries, coprolites from Suffolk and Cambridgeshire, phosphate from Spain, Sombrero guano, &c. Improvements have been introduced in the manner of mixing the acid with these substances, and in the riddling of the superphosphate. The quantity produced amounts to between 1,500 and 1,600 tons per annum.

Sulphate of Iron.—The first manufactory for the production of green copperas in England was founded about the year 1579. The quantity at present manufactured is about 2,000 tons per annum, and the process is still the same, but Mr. Barnes has applied the refuse crystals to a novel purpose. This refuse is generally thrown away, but Mr. Barnes uses it as a manure on his farm, on the thin soil, which lies on the Magnesian Limestone.

Sulphate of Copper.—This salt was formerly produced by roasting old copper in a reverberatory furnace, and then dissolving the oxide in sulphuric acid, but it is now obtained in carrying out Longmaid's process for decomposing common salt by means of cupreous pyrites. The quantity made is about 100 tons per annum, which is all produced at the works of Messrs. J. and W. Allen.

## REPORT ON THE METALLURGY OF THE DISTRICT.

This paper, by Messrs. J. L. Bell, T. Sopwith, Dr. Richardson, and T. Spencer, may be conveniently divided into the three following heads :—

### The Manufacture of Iron in connection with the Northumberland and Durham Coal-field.

There is probably no district where the manufacture of iron is carried on which presents more features of interest, and embraces within its range greater variety, than that which is worked in connection with the coal-field of Northumberland and Durham. Notwithstanding this, the iron metallurgy of the north, which it will be the province of this paper to explain, owes none of its importance to the existence of any of the ores of iron being found in those measures which belong more immediately to the coal formation. In Scotland, Staffordshire, and South Wales, the shales of the Coal-measures contain bands and nodules of ironstone in sufficient quantity to supply immense works, established in these localities, for smelting iron. The coal-field of the north of England, on the contrary, extensive and productive in mineral fuel as are its strata, is sin-

gularly deficient in those ores of iron which distinguish many other carboniferous districts. An explanation, then, of the prominent position occupied, as a seat of the iron trade, by the locality under consideration, must be looked for in another direction, and a very brief mental survey of the geology of the adjoining country will furnish the necessary information. Starting from the coal-field itself, which, as containing the fuel required for smelting, may be considered as the keystone to the whole, we arrive within no great distance at strata which abundantly compensate for that poverty in ironstone already spoken of as inherent to our Coal-measures themselves.

The district known as the Newcastle and Durham coal-field contains an area of something like 700 square miles, and in shape may be roughly considered as an isosceles triangle, having its apex coincident with the coast line at Warkworth. As the sea principally forms its eastern barrier, our observations are necessarily almost exclusively confined to those formations bounding it on the west and south. In the former direction, *i.e.*, towards the west, a narrow strip, having a width of four or five miles of the Millstone Grit rising up from under the coal formation, separates this latter from an extensive tract of country, of which the Mountain Limestone is the prevailing rock. From the south-west corner of our coal-field, and separated from it by a great expansion of the Millstone Grit accompanied by Mountain Limestone, we pass over a thin wedge of the Old Red Sandstone, and enter upon the New Red, to the west of which the Carboniferous Limestone again appears as a long, narrow, and curved-shaped district, extending from Penrith to Whitehaven, and of importance in describing our subject. On the south, and skirting the coal-field on the south-east, we have the Magnesian Limestone, some half-dozen miles in width. Beyond it, forming for some distance the valley of the Tees, is the New Red Sandstone, separating, by an interval of twenty miles, our collieries from the hills of Lias in Yorkshire.

Many of the numerous beds of shale associated with the coal formation in this neighbourhood contain, interspersed in their thickness, nodules of ironstone, but these have rarely been sufficiently abundant to lead to their being worked for smelting purposes.

Above the seam of coal known on the Wear as the High Main, and separated from it by a distance of 18", is a continuous band of this ore. It is 4½" thick, and was formerly wrought on Waldridge Fell for the Whitehill Ironworks, and subsequently at Urpeth and its vicinity, for the furnaces at Birtley. Another thinner band, only 2" in thickness, formed the roof of the Hutton Seam, near Birtley. From the fact that both these were extracted by simply bringing down the roof of the old coal workings, it was expected to supply the furnaces there at a very cheap rate, and this might have been so had the quantity per acre been larger. As it was, the ironmasters had to seek far and wide for supplies, and, in consequence, the cost of stone was ruinously high. In 1812, the ironstone per ton of iron cost the Tyne Iron Company 2*l.* 18*s.* 10*d.*

Near Wylam a mine was opened in 1836, out of which, from a section of 4′, four bands, measuring together 10½″, were obtained. This cost, it was stated, 7*s.* 6*d.* per ton, and yielded 30°/$_0$ of iron. Another working supplied nodules, having a percentage of from 35 to 37, and costing 11*s.* 6*d.* per ton. The united produce, however, of both did not suffice to supply 150 tons weekly; and these mines were speedily abandoned when a less precarious mode of obtaining ironstone offered itself, although the cost of the latter would, at the period of its first introduction, have not been less than 2*l.* on the ton of iron.

At Shotley Bridge, on the western edge of the coal-field, is a deposit of ironstone which has been far more extensively worked than any other seams found in these Coal-measures. According to a description by the late

Mr. William Cargill, in a working having a section of about 7′ in height, 12″ to 15″ of stone was obtained from six or seven bands. The ironstone from it cost 7*s.* to 8*s.* per ton. At a depth of 4½ fathoms below it, and lying above 20″ of coal, is a bed of shale about 3′ feet thick, containing 6″ to 7″ of ironstone. The total yield of both seams contained in an acre of ground Mr. Cargill estimated at 5,324 tons. In later years, however, according to a detailed report communicated by Mr. Edward T. Boyd, the average produce of the first-mentioned seam, "The Ten Band," as it was called, at that time was 8″ of ironstone, in a working of 5′ 9″ high, and in the other bed his section gives—

| | ft. | in. | ft. | in. |
|---|---|---|---|---|
| Good coal .. .. .. .. .. .. | 1 | 6 | | |
| Splint ditto .. .. .. .. .. .. | 0 | 7 | | |
| | | | 2 | 1 |
| Ironstone .. .. .. .. .. .. | 0 | 4½ | | |
| Shale .. .. .. .. .. .. .. | 3 | 6 | | |
| | | | 3 | 10½ |
| | | | 5 | 11½ |

For a limited supply, the quantity of ironstone found in this neighbourhood might have sufficed; but an immense work having been erected upon it, comprising fourteen blast-furnaces, serious inroads were soon made on its resources. From information formerly received, it would not appear, whatever might be the richness of clean stone, that its yield, as delivered to the furnaces, exceeded 26°/₀. A small quantity of ironstone continues to be extracted from a landsale colliery at Hedley, which is smelted at Wylam, and some is still worked by the Weardale Iron Company, near Tow Law. In a general sense, however, it may be assumed that ironstone of the coal formation of the north of England forms no element at the present day in the consumption of the blast-furnaces of that district.

In the deposits of ironstone connected with the Mountain Limestone, there occurs a bed of shale 30′ in thickness, in the whole of which considerable quantities of nodules of ironstone are interspersed. This deposit has been somewhat extensively wrought at Hareshaw and Ridsdale, as well as attempted at other places. In all these localities, however, the workings have been discontinued.

At Chesterwood, about two miles from Haydon Bridge, there was opened out, some years ago, a seam of what in some measure resembled the famous "Blackband ironstone" of Scotland, containing, however, much more coal than the celebrated ore of this name. It varied from 2′ to 4′ in thickness. The raw stone contained 20 to 24°/₀ of iron, but instead of 2 tons of raw mineral producing 1 ton of calcined, as in the case of Scotland, 3 tons were required at Chesterwood; so that the richness of the calcined stone was about the same, viz., 60°/₀. The deposit has been traced to other places, but in each case it is thin and poor in metal.

In Alston Moor many of the mineral veins traversing the Mountain Limestone contain a considerable quantity of a hydrated peroxide of iron as well as amrophous carbonate of iron. A bed of the latter lying on the surface, but of very limited extent, was worked at Nent Head, and smelted at Wylam. The iron produced from it, as well as from other carbonates and oxides from the same district, was of excellent quality; but the supplies were too uncertain and too costly. The ore in the veins themselves at one time was tolerably pure carbonate, yielding perhaps 30°/₀ or more of iron; but it gradually passed into carbonate of iron, from which it was with difficulty distinguished. At present only a small quantity is worked at Alston. On the other hand, at Weardale the veins contain so much carbonate and oxide of iron that furnaces have been erected at Tow Law, by Messrs. Attwood and Baring, for their reduction.

The small district of Mountain Limestone stretching from Penrith to Whitehaven contains very large quantities of most valuable red hematite, containing 60°/₀ and upwards of iron. It is sold at Whitehaven at about 10*s.* per ton. Its position is uncertain in a mining point of view, occurring in detached masses of varied thickness. This locality, as well as that near Ulverstone, of a similar character, is of importance in connection with the northern coal-fields, inasmuch as considerable quantities of the hematite ore are brought over to the east coast as a mixture with our own ironstone; while, to the furnaces smelting the produce of the Whitehaven mineral field, coke from our side is conveyed.

The Lias rocks of Yorkshire constitute by far the most important source from which the needful supplies for our furnaces are derived. The seams of ironstone belonging to this formation crop out on a considerable extent of the coast line of the shale beds, which, in addition contain large balls of the same ore. In rocks so liable to disintegration from atmospheric influence these have fallen away, and in consequence considerable quantities of ironstone, freed from the adhering shale, are to be found on the beach as rounded pebbles, and even as masses of rock. In modern times the ore so separated from its parent bed attracted the attention of those ironmasters who commenced smelting the ironstone of the coal-field. The exposed character of the Yorkshire shores and want of shelter rendered the conveyance of ironstone to the Newcastle furnaces a task of great difficulty and of some danger; and it was, therefore, not until the stratum furnishing it was discovered inland on a line of railway, at that time recently opened, that any large quantity of this Lias ironstone was consigned to the ironmasters of the Tyne. It is stated that the discovery of this bed is due to a Mr. Wilson, who pointed out its position at Grosmont, about five miles from Whitby, in 1836. The seam, being 4½′ thick, was cheaply worked, sent down the railway, and shipped at all seasons for the Tyne, where it would at that time cost about 9*s.* per ton. It is probable that ultimately as much as 80,000 to 100,000 tons of it were annually smelted in the north country furnaces.

Much surprise has been expressed at the time which elapsed between this discovery in 1836, and the period when the importance of the bed of ironstone became so immensely increased by the large quantity of ore extracted from mines opened in it since 1850. This is not so difficult of explanation as might at first appear. The Whitby ironstone, as it was then generally called, was known over a distance of coast not far short of ten miles, and its character to the west, five miles inland, had been also sufficiently explored. Over the whole of this area, its yield of metal had been uniform, namely, about 25°/₀. No doubt the owners of the blast furnaces, which had been built on the Tyne for smelting local ores, were too glad to obtain a cheaper stone elsewhere, particularly when hot blast increased the consumption of their furnaces, already indifferently supplied, and competition with Scotland ran down the price of iron. Whitby harbour, for these firms, was more convenient than the Tees, because vessels coming down in ballast more easily ran into the former than up the somewhat intricate navigation of the river, and there was no reason to suppose that a seam of ironstone which had so uniformly maintained a low percentage over fifteen miles of country should, in this respect, as well as in others, change so rapidly in the next dozen miles. That the introduction of the stone from Whitby did not confer any great advantage on the Tyne smelters is proved by the fact that, for fourteen years after its discovery, only two furnaces, and those built under somewhat peculiar circumstances, were added to the five in blast previous to the importation of this ore. The fact was that, with the exception of one or two years, the Tyne never could compete in selling "mine" iron against the market price of the Glasgow makers. Between 1840 and 1850, the cost of ironstone on

the ton of iron was never, at the Birtley Iron Company's works, less than 26*s*. 3*d*. The average selling price of iron at Glasgow over eleven years was within 6*d*. of the cost at the Birtley Iron Works, and to obtain this the owners must have charged the coal from their own pits at less than 2*s*. per ton laid down at the furnaces.

In 1840, Messrs. Bolckow and Vaughan, who had built a rolling-mill at Middlesboro' in 1840, added, at Witton Park, in 1846, the process of smelting to their operations. They were induced to do so by an offer of ironstone to be supplied from the coal-field near Bishop Auckland. In these expectations, as had happened to their colleagues on the Tyne, they were disappointed, and like them, they had recourse to Whitby. Examination of large detached masses which had fallen from the cliff led Messrs. Bolckow and Vaughan to Skinningrove on the coast, at which place they found the bed had thickened out from 4½′ to nearly 14½′, and instead of 25°/₀ of iron, it contained 31. So far was accident, but that firm experiencing the usual inconvenience arising from an exposed place of shipment, sought for, and found in 1850, the position of the ironstone inland. The Lias rocks contain other beds of ironstone, to which reference will be hereafter made, when the composition of the Main Cleveland Seam and its uses as an ore of iron are spoken of.

Thus, in a district embraced within the four counties of Northumberland, Durham, Cumberland, and Yorkshire, the coal formation contains the usual clay ironstone; the Mountain Limestone has furnished, to a limited extent, some black-band and nodules of ironstone, and is now affording spathose ore and brown hydrated peroxide of iron, as well as very large quantities of the finest red hematite; lastly, in the Lias beds of Yorkshire, there are found inexhaustible deposits of an argillaceous ore. Besides these, some small quantities of other ores, both foreign and British, are conveyed to the Tyne, but not to an extent to render them worthy of especial notice.

Notwithstanding the varied character of the different ores of the district, and the want of metallic contents of some, the property that even these have of "rusting" on exposure to air and moisture appears to have made known the existence of all at a very early period. There is little doubt that the smelting of iron ore was carried on to a considerable extent in this part of the country during its occupation by the Romans. Vast heaps of iron scoriæ may be seen on the moors of Durham, and in the valleys of the Reed and the Tyne, on the Mountain Limestone, in Northumberland. The same observations respecting an early use are, to some extent, applicable to the Lias ironstone, and no doubt proper investigation would indicate a similar state of things wherever iron ores were near the surface, and the state of society required the metal they contained. Of course, all these smelting operations have reference to the small bloomery or hearth in which, with a little ore and some charcoal blown by the wind in exposed situations, or subsequently by rude bellows, a "bloom" of malleable iron was obtained.

The German colony of ironworkers at Shotley Bridge established themselves at that place in the reign of William III. At some time or another afterwards a small high-blast-furnace, 5′ or 6′ in the boshes, was erected there, the remains of which are still visible. Wallis, in his *History of Northumberland*, published in 1769, mentions an ironwork which existed some years previously at Lee Hall, near Bellingham, under the management of a Mr. Wood, "who made a good deal of bar-iron, but charcoal becoming scarce he removed to Lancashire, where he attempted (unsuccessfully) to make it with pit coal." Although bar-iron only is mentioned, there is no doubt, from the remains still existing, that Wood also produced pig-iron. Charcoal iron was also smelted from some of the bands of clay ironstone at Bedlington, where the old calcining kilns are still visible, or were so until

very recently. No iron, however, has, as far as can be ascertained, been made there for more than a hundred years.

The inroads which iron smelting, together with other metallurgical operations, &c., had made upon the forests were such, that in the reign of Queen Elizabeth four Acts of Parliament were passed to restrict the consumption of timber, especially when applied to the manufacture of iron. To supply the deficiency thus occasioned, schemes were proposed so early as 1612, and subsequently in 1621, for smelting iron with pit coal. The unsuitability, however, of the arrangement in use for smelting with charcoal when applied to mineral fuel, in all probability delayed this important amelioration taking effect for a hundred years after its first suggestion. The small furnaces and bellows of very limited power, which did very well with charcoal, would be literally useless when applied to coal or to coke. After various ineffectual attempts about 1713, the Darbys of Staffordshire reduced the application of pit coal to one of practical utility in that county. Darby's progress, however, must have been slow and his success limited, for the number of blast-furnaces in the country had, in the meantime, decreased from 300 to 59, so that in 1740 the make of pig-iron in England had fallen to 17,850 tons, from about 180,000 tons; the chief portion of our requirements being imported from Sweden and Russia. To Mr. I. Cockson the merit belongs of erecting and working the first blast-furnace with coked coal, in the north of England. The Whitehill furnace was 35′ high, 12′ across the boshes, and produced 25 tons of iron per week. The blast was supplied by the bellows, worked by a water-wheel. Its supply of ironstone was from the thin bands on Waldridge Fell and from Robin Hood's Bay; the coal, of course, was obtained from the immediate vicinity. The iron was used for colliery castings, and latterly for Government ordnance. Frequent interruptions for want of water to drive their wheel, led at length to the furnace being ultimately abandoned, about the close of the last century.

Whatever advantages, in point of ores, any district might stand possessed of, its powers for turning them to profitable account depended at that time on the existence of a fall of water sufficient to drive the needful blowing apparatus. The discoveries of Watt prevented the want of hydraulic power being any longer an impediment, and in a short time the obedient steam-engine was appointed to supply the necessary blast to iron furnaces. Notwithstanding the poverty of our coal-field in ironstone, the high price of iron—8*l.* per ton—and the small quantity of ore required for a furnace, when 40 tons of iron was the usual week's make, induced the Tyne Iron Company, in 1800, to erect their two furnaces and a steam blowing engine at Lemington.

In 1825, pig-iron rose to the unprecedented price of 12*l.*, and as a considerable portion of the stone smelted by the Tyne Iron Company was the produce of pits at Urpeth and its neighbourhood, Messrs. Perkins, Hunt, and Thompson, who were extensively engaged in coal mining in that locality, blew in two furnaces in 1830, which they had built at Birtley.

In 1836, the furnace at Wylam was put into blast by Messrs. Thompson Brothers, to smelt ironstone expected to exist in great abundance there.

We have now arrived at that period in the history of the iron trade which was followed by a gradual, but ultimately an entire change in the sources from which the furnaces of this district derived their supplies of ironstone. So early as 1836 a cargo of that ore was sent from Grosmont, near Whitby, to Birtley. In the year 1833, and up to 1839, pig-iron had ranged from 4*l.* 10*s.* to as high as 9*l.* per ton in Wales. The demand for iron in this neighbourhood was so vastly on the increase that the ores of the coal strata could not meet the growing requirements, and the Whitby stone had not inspired much confidence either for economy or quality of the iron it produced. In consequence, speculators began to pay attention

to those deposits of ironstone spoken of as being connected with the Mountain Limestone, and Ridsdale was the place selected, where coal could be obtained from a seam from 2′ to 2½′ thick, situated in the same geological formation.

Although pig-iron had fallen in 1840 to *3l.* *12s.* *6d.* at Glasgow, and in 1841 was selling at *3l.* *5s.* per ton, a second work, to smelt the same bed of ironstone with the coal 2½′ thick, lying 70 fathoms below the ironstone, was put in blast at Hareshaw; a second furnace was subsequently built at Ridsdale, and two more at Hareshaw. There is no doubt that the iron produced from this bed of ironstone was of a very excellent description. Both works, however, were nearly twenty miles from a railway, and twenty more from a market, so that their iron cost *12s.* per ton for carriage to the consumer. After some years of fruitless struggle to meet the competition offered by Glasgow, both of these establishments were closed, and finally dismantled.

About 1840, Messrs. Bigge, Cargill, Johnson, and others, who had purchased the Ridsdale Works, had their attention directed to the beds of ironstone lying in the Coal-measures, near Shotley Bridge. A pair of furnaces were speedily erected, and set in blast. A larger company was formed, and an immense establishment was constructed. Twelve blast-furnaces were built, large rolling-mills, and all the necessary mines, mining villages, &c., followed in rapid succession. Until 1850, the furnaces went on devouring the ores found in the neighbourhood at an alarming pace, having in the meantime made extensive trials of those from the lead veins of Weardale. In 1850, the recent discoveries in Cleveland promised relief from the impending famine, and in a very short time, in spite of a distance of about fifty miles, the ironstone from that district, with some hematite for a mixture, entirely superseded the stone lying adjacent to the furnaces.

In 1842, Messrs. Losh, Wilson, and Bell, who for fifteen years had been making bar-iron, built a blast-furnace at Walker for producing forge-pig by smelting their mill-furnace cinders with Whitby stone, and this was followed by a second one in 1844, so that these were the first furnaces ever built expressly for smelting the recently discovered ironstone at Whitby.

About this period Mr. Attwood, in concert with Messrs. Baring and Co., purchased a small furnace then recently erected at Stanhope by Mr. Rippon, and built five others at Tow Law for smelting the "rider ore" (carbonate and oxide) of the lead veins. There is no doubt that, owing to the extreme irregularity of this kind of material, immense labour and expense were at first incurred, and, as regards the quality of the produce, frequently with very unsatisfactory results. Better acquaintance, however, with the veins and their contents has enabled that firm to produce iron of a very high class—so good indeed as closely to resemble in composition and quality the celebrated German "Spiegeleisen." For bar-iron purposes it bears a high name, and has, like its prototype in Germany, been found well adapted for the manufacture of the finer kinds of steel.

Although only remotely connected with our subject, it may as well be mentioned that a company of gentlemen had erected at Cleator Moor, near Whitehaven, a couple of blast-furnaces for smelting the hematite iron ore of that district, an example which has been somewhat extensively followed since. The iron made is of good quality, and the ore being rich, an immense quantity, as much as 500 tons weekly, or more, from one furnace is said to have been run.

Mention may also be made of other trials to render available the bed of ironstone nodules of the Mountain Limestone. This was attempted at Brinkburn, on the Coquet, but after a very short trial the works were closed. Another experiment was made at Haltwhistle with a similar view, but it also was abandoned soon after the erection of the works. At Bed-

lington two furnaces were constructed to smelt the same bands formerly used at the charcoal works in that locality, with an admixture of Yorkshire stone, mill cinder, and other materials, but these also were only a short time in operation.

Notwithstanding the varieties of coal which occur in the northern coal-field, the whole, with few exceptions, are more bituminous in character than the produce of other localities in this country. The caking property, although very valuable for many purposes, entirely unfits the coal of this district for use in the raw state in blast-furnaces, where its fusing property, by impeding the blast, causes the contents of the furnace to hang and slip, and thus to descend at irregular intervals. Against this disadvantage, however, possessed by our coal, may be placed the extreme hardness and strength of the coke it produces, which is thereby rendered capable of resisting the crushing effect of a high column of materials as they exist in blast-furnaces.

The purity of the coal is by no means an infallible indication of its fitness for the manufacture of a suitable coke for iron furnaces. Not only is comparative freedom from ash and sulphur indispensable, but there must be concurrently the power, which depends on some circumstance not clearly understood, of producing coke sufficiently compact to come down to the region of fusion in the furnaces, without being much crushed on its way.

The Magnesian Limestone, although differing little in colour, &c., from the rock in other localities, is nearly entirely carbonate of lime, and the Mountain Limestone almost invariably, from its purity, satisfies the conditions required by the iron smelter. These two, but principally the latter, with a little chalk, brought by coasting vessels as ballast, constitute the flux in the iron-furnaces.

Mr. Bewicke gives the dimensions of the field of ironstone of the Lias as thirty miles by sixteen, from which he deducts sixty miles for denudation, giving a net area of 420 square miles; he roughly considers the yield to be 20,000 tons per acre, and hence infers that close on 5,000 million tons are contained in the Main Cleveland Seam, within the limits laid down. In some places this seam is more or less split up by bands of shale, which, of course, interferes greatly with its commercial value. At Grosmont, near Whitby, there are found two seams of ironstone known as the pecten and the avicula bands. The former consists of 3′ of ironstone, divided in the middle by a bed of shale of 1¼′ thick. Separated from this by 30′ or more of shale, is the other seam, the avicula, embracing 4½′ of ironstone, along with 2′ of shale, and it is by these two bands uniting, as well as increasing in thickness, that we have further north the Main Cleveland Seam, as it is termed. At Codhill the bed has an extended height, but is so interspersed with foreign matter that it is found necessary to confine the mining to a section of 5½′; and the produce, from the circumstance of more or less shale bands running through the ironstone itself, only yields about 28 °/₀ of metal. A little to the east of Codhill are the Belmont mines, where the shales thin out, and in consequence the yield of iron is about 30 °/₀, the seam at the same time having increased in height to 7¼′. At Skelton, still further east, a marked improvement, both in thickness and in quality, is again discernible. The workings there are frequently 10′ high, and a recent analysis of the entire section of stone gave about 36 °/₀ of iron. The north side of the vale of Guisbro' is formed by an elevated ridge of land separating this valley from that of the Tees. At the western edge of this ridge are the Normanby mines, where the stone is worked at an average thickness of about 8′, containing 31½ °/₀ of iron. There is a general dip of the seam to the east from this point, and in its progress in that direction there is a gradual increase in thickness, and a little improvement in percentage of iron. It continues in this way past Eston and Upleatham, until it reaches Rockcliffe, where it attains a thickness of nearly 18′, after which

it splits again into bands, and, as far as is known, resumes towards the east and south the character formerly observed as attaching to it at Grosmont, near Whitby.

It will be thus seen that, although the quantity of ironstone in the Main Cleveland Seam is practically inexhaustible, the portion which, in recent years, has yielded such immense quantities of rich mineral, as far as we can at present judge, occupies comparatively a very limited area. Commencing at Swainby, near Osmotherley, which is the most western point where the bed is worked, its thickness is not much above 3′, and the percentage of iron under 28. It improves gradually in a north-eastern direction past Kildale, where a working was attempted, and abandoned, by the writer's firm. It is not until we reach Codhill, thirteen miles from Osmotherley, that the seam is considered worth extracting; and a line from this point to Rockcliffe, on the coast, a distance of twelve miles, will probably be found as forming the southern boundary of the best stone, so that after making the necessary allowance for denudation, twenty to thirty square miles may be assumed as the extent of the area, of which a considerable portion lies at a great depth.

Much more irregular in its features is the so-called top seam. At Normanby and Eston little more than its position can be recognised, and throughout the entire field it varies from a few inches to many feet in thickness. In richness of iron it is not less changeable, giving from 20 to 35 °/₀ of metal, according to the locality from which the sample may be taken. In the main seam there exists a certain degree of uniformity, even in the change of thickness and richness; but in the top seam both alternate very frequently in a most unlooked-for manner. On the western side of the district Ingleby Greenhow is the most northern, and indeed the only place where the top seam has been wrought in that direction. In the mine there its thickness was 2′, and richness in iron 34·75 °/₀. On the other side of the valley it thinned away to a few inches, containing 37·65 °/₀ of metal. Near Osmotherley the seam is several feet thick, and in it a few inches at the top contain 41 °/₀ of iron; this is succeeded by 3′ of stone, with 24·5 °/₀ lying upon the top of 10′, giving 16·70 °/₀ of iron. On the east coast, at Port Mulgrave, Messrs. Palmer formerly worked a small district of the top seam, 4′ to 4½′ thick, which on analysis gave 30·99 °/₀ of iron. In Goadland Dale, Glazedale, Fryup Dale, and Danby Dale, this seam varies from 5′ to 8′ or 9′ in thickness, and yields from 20 to 25 °/₀ of iron. In one case it is as low as 9·33, and in another case as high as 30·11°/₀, but both of these results were from a very limited area. Unless the magnetic ironstone worked at Rosedale Abbey is a portion of this top seam, about which some doubt has been expressed, all the workings in connection with this bed have been abandoned.

A word or two respecting the mode of extracting the ironstone from the main Cleveland seam in the northern portion of the field, *i.e.*, near Middlesbro', will not be altogether superfluous. There is a portion of the bed at the top 3′ thick, over and above the heights of the seam formerly given, and separated by a parting from the remainder of the bed, which parting varies from being a mere point of separation to a thickness of 6″ or 7″. When it attains this latter thickness, or even less, its contents are so impregnated with bisulphide of iron as to give 28°/₀ of sulphur. This band being easily detached from the ironstone, was applied in the chemical works at Washington as a substitute for ordinary pyrites, and continued to be so used until a manufactory at Middlesbro' was able to consume all the produce of the district on the spot. The 3′ is left in the workings to form the roof of the mine. The remainder of the seam varies from 8′ to 10′ in height, and, indeed, occasionally reaches 16, or even more. In extracting the stone, headways are driven 9′ wide and 90′ apart, from which, at intervals of 30′, boards are excavated 15′ wide.

By this system "pillars" are left 90′ long by 30′ wide. When the limits of the royalty are reached, or when, from any other cause, it is deemed necessary to work the pillars, they are removed with something like a loss of 10°/$_0$ of their contents, so that in a good working, free from faults, the whole of the ironstone within perhaps 7½°/$_0$ can be brought away.

The relationship existing among the earthy constituents of the Cleveland ironstone varies somewhat in different localities. This is not to be wondered at, for in fact the seam itself in the same section is by no means uniform in its composition. A moment's inspection of the furnaces working the ironstone of the district, enables a practised eye to perceive a very marked difference in the general character of the slag compared with that usually seen at ironworks. Although it flows hot and fluid, it is extremely stony in its fracture, with scarcely a vestige of a vitreous nature. On comparing the composition of the slags from the Welsh, Staffordshire, and South Yorkshire works with those from the furnaces in Cleveland, the great dissimilarity in constitution is at once perceived, and examination will show, that with the composition of our ores no mere addition of lime can ever imitate the vitreous slags of those localities just mentioned.

The uniform practice in the whole district is to blow the furnaces with heated air. Sufficient data are not possessed to enable us to speak with any degree of certainty respecting the application of cold blast; but as far as actual experience goes, it is in favour of the idea that Lias ironstone would prove very intractable under that mode of smelting. In the year 1841, from some reason or another, cold air was used during four months at Birtley. The furnaces only ran 42 tons per week of white iron, produced by a consumption of 3½ tons of coke to the ton. At Clarence an attempt recently was made to operate on the Cleveland ore in the same way; twice the quantity of coke was used which is required when making foundry iron, and only white pig was obtained. A more elevated temperature being wished for than is easily commanded by means of heated iron pipes, various experiments were tried at the Clarence works, and ultimately Cowper's stoves were introduced. At the Wylam and Wear Ironworks an arrangement has been adopted by which the blast is heated by means of the waste heat from the coke ovens.

In shape, the blast-furnaces present no novelty worthy of notice. The width of the boshes varies from 14′ to 18′, and the height from 42′ to 55′, in one case 75′ having been reached with beneficial results. An average proportion will, probably, be three diameters of the boshes to the entire height, but no great importance can be attached to this ratio, inasmuch as the furnaces continue to work well long after the destruction of the lining has greatly altered the dimensions just given. One attempt has been made here to employ Alger's furnace, in which the circular horizontal section is replaced by one of an elliptical character. In this form the iron is tapped, and the slag allowed to run from the back as well as from the front of the furnace. At the Stockton Ironworks, where the system has been tried, the major axis of the ellipse is 12′, and the minor 5½′ in the hearth—the higher part of the furnace (which is an old one altered) remains circular. The blast in the north of England is introduced generally by three or four twyers, at a pressure varying from 3 to 4 lbs. per square inch, and at a temperature of about from 600° to 700° Fahr. The production of a furnace is from 200 to 220 tons weekly, although more than this quantity has been frequently obtained.

Malleable iron was of course the description of metal produced at those bloomeries the remains of which are indicated by heaps of scoriæ. With cheap fuel and water-power in sufficient quantity to drive small hammers, forges were erected at Swalwell, Beamish, Lumley, Bedlington, and other places. In the year 1800 a small rolling-mill was erected at Lemington,

and in 1827 a mill was erected at Walker, capable of rolling from 80 to 100 tons per week.

It is needless to follow up at any length the increase in the manufacture of malleable iron during the time which intervened between 1827 and that of the discovery of the main seam of Cleveland ironstone. This being of so recent a date, the second stage of manufacture has not, as yet, received that complete amount of development which the great advantages possessed by the district are calculated to confer upon it. There would be, previous to 1850, in the district about 300 puddling furnaces, capable of turning out 150,000 tons of finished iron per annum. At present, the number will be about 560, with a power of producing about 280,000 tons of finished iron. At first a much stronger opinion existed in favour of refining pig-iron previous to puddling it than is the case at the present moment. In fact, it may be said that this mode of working has been all but abandoned as more wasteful than simply puddling the pig-iron direct. At the new works no refineries are built, and at the older establishments the refineries are discontinued. There are probably less mill and forge-cinders used in the manufacture of pig for bar-iron, or other purposes, than in any other district in the kingdom, and this obviously from the greater abundance and cheapness of ironstone. The extra loss in puddling and depreciation of quality in malleable iron being more than an equivalent for any saving in the blast-furnace, by the substitution of a material into which the major part of the phosphorus of the pig finds its way. It is also not improbable that the admixture of mill and forge-cinders might, with the constitution of the Cleveland ores, be more detrimental to the quality of the result than is the case in other districts. At all events our bar-iron makers seek to avoid any risk of this by its very sparing use. Some bar-iron manufacturers prefer pig having an admixture of a little hematite in the blast-furnace, or they seek to secure the advantages resulting from the use of this class of iron by using hematite pig in the puddling furnaces. It is highly probable some good results from such a course of procedure, as well from the acknowledged excellence of hematite pig as from the advantage generally allowed of using different varieties in the manufacture of malleable iron. The fact, too, that the tendency of the Cleveland iron is towards cold shortness, while that of the hematite is in the opposite direction, increases the probability of the soundness of these views. At the same time by careful puddling and subsequent manufacture, bar-iron of a very high class of excellence can be produced from pig obtained from Cleveland ironstone alone. Many of the mills being of recent construction, embrace all the recent improvements. Very powerful steam hammers forge down the puddled balls so rapidly into blooms or slabs, that two of these are frequently taken simultaneously to the puddling mill and rolled out by "doubling" into a single bar, of dimensions varying with the subsequent destination of the product. Finishing mills of great power have been constructed, capable of rolling rails, bars, angle and girder iron of any section, and of the greatest lengths produced in this branch of manufactures.

In the puddling furnaces different materials are employed in different localities for protecting the iron bottoms. In some places the plastic hematite from Lancashire is used, in others limestone. In most cases, however, "bulldog," *i.e.*, calcined mill furnace scoriæ, ground and mixed, frequently with a small quantity of red ore, is found a good covering, and capable of resisting the corroding action of puddling pig, which is more rapid than where refined metal, or a mixture of refined metal and pig, is used.

A few words to indicate in a statistical point of view the present position of this important branch of our local industry must bring this paper to a close. Were all the blast-furnaces already constructed or in

process of building actually in operation, they would be capable of producing double the quantity of iron estimated from the returns of the geological survey; but accepting those returns as the basis of calculation, there will have been consumed during the year 1861, as follows:—

| | |
|---|---|
| Ironstone .. .. .. .. .. | 1,690,000 tons |
| Coal .. .. .. .. .. .. | 2,380,000 „ |
| Limestone .. .. .. .. .. | 345,000 „ |
| | 4,415,000 „ |
| The capital employed in mines, furnaces, works, &c., will be a little under .. | £2,000,000 per annum |
| The annual amount of wages will be about .. | 950,000 „ |
| Dues paid to railways for carriage .. .. | 350,000 „ |

### Lead Metallurgy of the District.

These mining districts are chiefly situated in or near the centre of that narrow portion of Great Britain, which is formed by the counties of Northumberland, Durham, Cumberland, and Westmoreland, and may be considered as being nearly in the central portion of the whole island, being situated nearly midway in its length from north to south as well as from east to west between the German Ocean and the Irish Channel. Under the level lands which lie near to the eastern and western coasts, the upper portion of the carboniferous series of rocks contains numerous and valuable beds of coal. From beneath this coal strata the "lead measures," as they are locally termed, that is to say, the several beds of limestone and other rocks in which veins of lead ore are chiefly found, gradually rise in a westerly direction with an inclination exceeding that of the general rise of the surface until they bassett or crop out at the surface over a wide range of country, reaching their highest elevation at the mountain of Cross Fell in Cumberland, and other adjacent fells or mountain moorlands which extend in a north and south direction so as to form a western limit to the lead mining districts.

The strata which extend between the outcrop of the lowest of the coal strata and the Cross Fell ridge of mountains are well known in the district as the Carboniferous or Mountain Limestone formation—so called from the abundance of coal so nearly associated with them, and from the numerous beds of limestone which prevail. These lead mining strata lie nearly midway in the series of formations which are known in England, being as much below the tertiary beds of the south-east part of the island as they are above the silurian rocks on the borders of Wales. A lofty range of elevated land extends from the borders of Scotland to Derbyshire, occupying from twenty to thirty miles in width of the middle portion of the north of England. In many parts of this range of hills are extensive lead mines; but the districts may be classed under the following:—1. Mining districts connected with the River Tyne and its tributaries,—the Trent, East and West Allen, and the Derwent, Alston Moor, in the county of Cumberland, East and West Allendale, in the county of Northumberland, Blanchland, and Derwent Valley, in the same county. In addition to these, which form as it were distant mining territories of considerable extent, other valuable mines in detached places have been discovered, and are extensively worked in the valley of the Tyne. 2. The extensive mining district of Weardale, in the upper part of the valley of the River Wear, and its tributary valleys of Burnhope, Kilhope, Wellhope, Ireshope, Rookhope, &c. 3. Another extensive district is Teesdale, in the upper part of the valley of the River Tees, the mines being situated chiefly in the county of Durham, and partly in Yorkshire. From many circumstances Alston Moor is best known as a

lead mining district from its having been open to public enterprise, and it forms a good type of the general condition of the lead mining districts. Of its early history, little is known. Traces of ancient smelting places exist, as may be inferred from the scoria yet to be found, but of any detailed operations or exact localities there is not, that I am aware of, any record. It is not until about six centuries ago that any light appears by which to judge of the state of the mining districts, and even then, and for some centuries after, few and far between and vague and undefined are the indications of lead mining. In the time of Henry IV, a lead mine is mentioned as having been in Essex, and Sir John Pettus enumerates the following counties as producing lead ore containing silver: viz., Devonshire, Gloucestershire, Worcestershire, Staffordshire, Leicestershire, Cheshire, Derbyshire, Lancashire, Cumberland, Northumberland, Yorkshire, Bishopric of Durham, Flintshire, Denbighshire, Shropshire, Carnarvonshire, Merioneth, Buckinghamshire, Montgomery, Carmarthen, Brecknock, Monmouth, and Dorsetshire. From this it may be seen that for a long period lead mining operations have been extensively spread over a great part of England and Wales, whilst in Scotland the chief works were almost confined to Lead Hills, a place where gold was formerly obtained in some abundance.

The earliest method of working lead mines appears to have been by shaft, by following the surface indications of ore downwards. The driving of levels for drainage in Dean Forest was of later origin, and probably so in the other mining districts of the kingdom. The work was drawn to the surface in kibbles, or small tubs, and some of the smaller pits on the bassett of inferior beds of coal yet present what probably was the appearance of a respectable mine in the infancy of such operations. The general use of levels or galleries large enough to admit of horses travelling in them, is said to have been introduced into the lead mining districts by Sir Walter Calonby Blackett about one hundred and twenty years ago, but the example was not, as I believe, followed for many years by other mine owners. Cast-iron rails, instead of wood, were first used in Nrent Force Level. Tin pipes were first used for ventilation by Low, Carlisle, and Co., at Tyne Bottom Mine. Mr. Stagg introduced iron pipes at Ramp-gill, and Mr. Dickinson first used lead pipes for the purpose of ventilation in the Nrent Force Level. Any of these materials were an improvement on the wooden boxes, which rapidly decayed, and so rendered the air impure, and which, moreover, could with difficulty be kept water-tight.

In conclusion, one prominent feature may be mentioned, viz., the work called the Blackett Level, commenced by W. B. Beaumont, Esq., M.P., in his manorial property in East Allendale. The shafts on this work were commenced in 1855, and the Adit Level, near Allendale Town, was begun in 1859. The entire length, when completed, will be nearly seven miles. At three of the shafts, and also at the Allenheads mines, are several extensive adaptations of the improved hydraulic engines invented by Sir William Armstrong, and particularly described by him at the meeting of mechanical engineers in this town.

The quantity of lead ore raised in this Northern district and smelted in the different mills, in 1861, was 37,053 tons of lead ore, 27,654 tons of lead, and 140,244 tons of silver.

Various important improvements have been introduced into the treatment of lead ores, among which may be mentioned the substitution of the Spanish Economico Furnace for the slag hearth, by means of which a better produce of lead is obtained from the refuse products of the mills. This Spanish furnace is a miniature blast-furnace, covered at the top, from which a flue conveys the fumes to the condensing chambers of chimney. Another improvement, introduced since 1839, is the celebrated desilverising process of the late Mr. H. L. Pattinson, by which large quantities of both lead and silver have been saved. This process is so well known that we do

not think it necessary to describe it on the present occasion, having been fully explained in a previous report to the British Association. A third improvement is the conversion of hard into soft lead by the process of calcining introduced by Dr. Richardson at Blaydon, in 1840. This process consists in exposing the hard lead in a melted state to a current of hot air, by which the antimony and other impurities are oxidised. The oxides float on the surface of the molten lead, and are skimmed off from time to time. This operation is continued until a sample of the lead drawn from the surface is found to be soft and malleable. The late Mr. George Burnett, sen., applied this process to the softening of Spanish lead, and employed a large metal pan, set inside the furnace in which the hard lead is melted. This improvement has been the means of developing a most extensive trade between this country and Spain. The Spanish ores on the east coast of Spain are smelted with the fuel exported from this country, and the hard lead is brought here to be softened and refined.

The total imports of lead into this country in 1861 were 23,109 tons, of which a considerable proportion was from Linares in Spain. This lead contains very little silver, and the average contents may be taken at 40 ozs. per ton on the total imports. The total production of British mines in 1861 was—Lead, 65,643 tons, and silver, 563,731 ozs. Hence, the imports and production of these metals in this district amount to 45°/$_0$ of the lead, and upwards of 50°/$_0$ of the silver of the whole trade of Great Britain.

This hard lead contains, on an average, about 50 ozs. of silver per ton, so that the quantity of silver extracted on the Tyne is now upwards of 600,000 ozs. per annum.

Several improvements have also been introduced for the condensation of the fumes evolved in the various smelting and refining operations to which lead is submitted. The first in point of time is the horizontal flue or chimney, which was first used by the late Messrs. Crawhall and Johnstone, in Mr. Beaumont's extensive mills. The flues are built of masonry, 8′ in height, and 6′ wide. The aggregate length of the flues in the mills belonging to Mr. Beaumont is nine miles. Another plan, adopted in the mills of the London Lead Company, is the invention of the late Mr. Stagg. It consists in drawing the entire gaseous products of the furnace through water, by means of powerful pumping machinery. The lead is completely condensed, and easily separated from the water on being allowed to collect and remain at rest in suitable tanks. Mr. Stokoe's plan has been introduced at Langley and other smelting establishments. In this plan the lead fumes are driven by a fan blast through a series of ascending and descending columns, partially filled with brushwood on pebble stones, down which a stream of water falls to condense the lead fumes. The water collects in tanks at the bottom of the columns, and the fumes ar[illegible]llowed to subside. We have heard that a small quantity of pure ore is r[illegible] crucibles by means of iron, similar to the process employed in t[illegible]timony ore, with the object of obtaining a lead of great purity, [illegible]luction of red lead for the manufacture of flint glass.

THE MANUFACTURE OF STEEL IN NORTHUMBERL[illegible]

The history of the manufacture of steel in this loc[illegible] very early period, for we find that, probably three hu[illegible] colony of Germans settled at a place on the river De[illegible] miles of th[illegible] according to tradition, the[illegible] branch of l[illegible]re they also attained some [illegible] facturers o[illegible]ls.

The ma[illegible]t present carried on i[illegible] prises the f[illegible] Blistered, shear, spr[illegible] to produce [illegible]terials are required :— the shape[illegible], coke, fire-brick [illegible]

these the iron and manganese are imported into the district, the former, for the best qualities of steel, being brought from Sweden. The charcoal, coal, coke, fire-bricks, and fire-clay are produced in almost inexhaustible quantities, and of most excellent quality, in the immediate neighbourhood. A small proportion of fire-clay, however, having to be brought from a distance for admixture with that found in the locality.

The mode of manufacture in use here is that known as the cementing or converting process, the furnaces used being large enough to contain from ten to about twenty-three tons of materials at one time; this material consists of selected iron, and known to the manufacturer as being most suitable for the purpose for which it is ultimately intended. It is placed in the cells of the furnaces with bruised charcoal in alternate strata, the whole being covered with a vitreous material to effectually exclude the air, and heat is applied for a period of about eight or ten days, according to the degree of carbonisation required. The mass is allowed to cool for several days, and the bars are then taken out in the form of blistered steel. The change that has taken place in its structure since it was placed in the converting furnace is very marked, for instead of now being of a fibrous nature, it is quite of a crystalline character, and it must be reduced or drawn out under rolls or heavy hammers to bring back to it something of its former nature. It is, however, used in the blistered state for many purposes, such as for welding into hammer faces, and for welding to iron for edge tools, and for spades and shovels, although cast-steel is now fast superseding its use even for these purposes. Spring steel is made by simply reducing with rolls the blistered bars, and shear steel is made by repeatedly drawing down and welding the blistered bars. This last-mentioned description is also being fast superseded since the introduction of mill welding cast-steel.

The most important of what may be termed the secondary processes of this manufacture is that for producing cast-steel, and it is (among the old methods of making steel) of the most recent introduction. Cast-steel is different from all the other descriptions of steel in its fineness of grain, greater strength, and its homogeneity. The first steel used in this country partaking at all of the nature of this description of steel was the Indian wootz, which was much prized by users of steel, especially by the makers of dies for coining presses. Cast-steel is produced by breaking the blistered steel into small pieces, and placing the same in crucibles or melting pots, capable of containing thirty-six to forty pounds weight each, two of which are placed in each melting furnace. A plentiful supply of coke is now filled into the furnaces, and, by the aid of a strong draught of air, an intense white heat is obtained and kept up for three or four hours, according to the nature of the steel required. When it is ascertained that the steel is perfectly melted, the crucibles are taken out, and their contents poured into iron moulds conveniently placed near, and left to stand until in a cool enough state to be taken out as cast-steel ingots. These ingots are afterwards re-heated and hammered or rolled, or, it may be, both hammered and rolled, according to the description of article for which it is intended [to] be used. To produce large ingots, a number of crucibles containing ... brought out of the furnaces, quickly following each other, ... stream is kept flowing into the mould. In the year 1839, ...nt was made in cast-steel by the introduction of

...steel by the cementing or converting process, as ...lled the indirect method, because the object of ... first instance, the pig-iron of the whole of ... nearly as possible, a pure malleable iron, ...in the necessary quantity of carbon to ...ods seem to aim, for the most part, at

making steel by a direct process, without depriving the pig-iron of the whole of its carbon, and without reducing it into a malleable-iron condition. This is effected by extracting a large portion of carbon, but taking care to leave in a sufficient quantity to make steel, the object being to save the great waste of metal attending the puddling of iron, as well as the actual cost of that process. Of these last methods, the Uchatius process is one that was extensively experimented on a few years ago, at the Newburn Steel Works, and the following is a short description of the manner in which the process was carried on. Pig-iron of a first-class quality was melted in a reverberatory furnace, and run into a tank filled with cold water, where it was reduced into granules; this granulated cast-iron was mixed with pulverised oxide of iron and some alkaline earths, and the whole put into the ordinary steel-melting crucibles, and then placed in the furnaces, to which heat was applied in the usual way until it was brought into a fluid state. By this method, it was thought that the degree of hardness of the steel was capable of being regulated by the size of the granules, and by the quantity of oxides used, but after a great number of experiments, at a cost of little under a thousand pounds, on attempting to work it in large quantities, it was found that the product was so uncertain in the qualities necessary to good steel, that the process was altogether abandoned. The irregularity of the produce was probably caused by the uncertain quantity of carbon in the pig-iron used.

A method of making "puddled" steel has been tried in this locality, but without success. This process was a patented invention of Riepe, a German, and consists in puddling cast-iron in a furnace constructed especially for the purpose until it is observed to be in the condition of steel. This state is found to exist when a particular form of bubble appears on the surface of the metal.

The Bessemer process of making steel has also been introduced into the district, at Tudhoe, near Ferryhill, but with what success the writer is not able to say. The operation, as is generally known, consists of blowing atmospheric air through a mass of melted cast-iron until the carbon and the whole of the impurities of the iron are burnt out of it. Experiments in making cast-steel from the Taranaki sand from New Zealand, and also from another similar sand from the coast of Italy, have been tried at Newburn, with a result of getting an excellent quality of steel; but although yielding about 51°/₀ of metal, the cost of its production, without including anything for the sand, was so great that it would not answer commercially. It may be mentioned that this description of metallic sand appears to possess the remarkable property of not becoming oxydised when kept in a moist condition, and the writer would call the special attention of chemists and metallurgists to the fact, with the view of arriving at what would be an invaluable discovery, the production of iron or steel that would not be subject to the destroying action of the oxygen of the atmosphere.

This district is highly favourable for the development of the manufacture of steel of the best quality, owing to the facility and cheapness with which a supply of iron can be obtained from Sweden, and also owing to an abundant supply of cheap fuel and labour in the neighbourhood. The business requires, however, the most vigilant attention of thoroughly practical and experienced persons in its management to attain any considerable amount of success.

# Abstracts and Reviews.

## THE *ANNALES DES MINES.*

*Annales des Mines, ou Recueil de Mémoires sur l'Exploitation des Mines, et sur les Sciences et les Arts qui s'y rapportent.* Rédigées par les Ingénieurs des Mines, et publiées sous l'Autorisation du Ministre des Travaux Publics. Sixième Série. Tome III et IV. 3e et 4e livraisons de 1863. Paris: Dunod, Quai des Augustins.

These two livraisons of the *Annales des Mines* contain among other papers interesting to our readers a long biographical notice on the late M. Dufrénoy, by M. Billy. The other papers are :—

Du Gisement et de l'Exploitation de l'Or en Californie, par M. Laur.

Lettre sur l'Exploitation du Semmering en 1862, par M. Desgranges.

Notes sur la Fabrication du Coke recueillies pendant un Voyage en Belgique et en Prusse en 1861, par M. Barré.

Théorie des Manivelles Multiples, par M. Haton de la Goupillière.

Rapport sur le Système de Locomotive Articulée et à Douze Roues Couplées, proposé par M. Rarchaert.

Note sur l'Application du Système de M. Rarchaert à une Machine Existante, par M. Bonnet.

Mémoires sur les Pétroles du Canada, par M. Gauldrée-Boileau.

Essais sur la Fabrication du Gaz d'éclairage au moyen du Pétrole, par M. H. Youle Hinde.

Note sur un Foyer Fumivore établi à Arlen, par M. Tenbrinck.

## THE BOARD OF TRADE RETURNS.

The "Accounts relating to Trade and Navigation of the United Kingdom, for the month ended 31st August, 1863, and eight months ended 31st August, 1863," have been issued by the Statistical Department, Board of Trade.

IMPORTS.—The quantities and relative increase and decrease of the imports of metals, metallic ores, and mineral products, for the month and eight months ended 31st August, have been as follows :—

| | Month ended 31st August. | | | Eight Months ended 31st August. | | |
|---|---|---|---|---|---|---|
| | 1862. | 1863. | Increase (+) or Decrease (—). | 1862. | 1863. | Increase (+) or Decrease (—). |
| Brimstone ... ... cwt. | 75,020 | 109,061 | + 34,031 | 751,916 | 493,085 | —258,831 |
| Copper Ore ... ... tons | 5,322 | 7,072 | + 1,750 | 57,412 | 52,679 | — 4,733 |
| Copper Regulus ... ... „ | 2,283 | 716 | — 1,567 | 25,232 | 12,467 | — 12,765 |
| Copper, unwrought and part wrought ... cwt. | 24,080 | 8,260 | — 15,820 | 176,300 | 157,080 | — 19,220 |
| Iron, in Bars, unwrought tons | 6,918 | 7,155 | + 237 | 18,990 | 23,278 | + 4,288 |
| Steel, unwrought ... „ | 217 | 468 | + 251 | 2,780 | 1,481 | — 1,299 |
| Lead, Pig and Sheet ... „ | 605 | 2,931 | + 2,326 | 13,702 | 17,156 | + 3,454 |
| Spelter or Zinc ... ... „ | 1,812 | 3,086 | + 1,274 | 9,991 | 17,670 | + 7,679 |
| Tin, in Blocks, Ingots, Bars, or Slabs ... cwt. | 6,912 | 8,295 | + 1,383 | 49,296 | 30,319 | — 18,977 |
| Silver Ore ... ... value in £ | 2,684 | 1,490 | — 1,194 | 196,693 | 178,471 | — 18,222 |
| Petroleum ... ... tuns | 2,037 | 2,338 | + 301 | 12,729 | 26,658 | + 13,929 |
| Quicksilver ... ... lbs. | 500 | 112,507 | +112,007 | 125,254 | 563,112 | +437,858 |

EXPORTS.—The quantities, declared value, and relative increase and decrease of the exports of metals, minerals, and metallurgical articles of British and Irish produce and manufactures, for the month and eight months ended 31st August, have been as follows :—

| | | QUANTITIES. | | | | DECLARED VALUE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Month ended 31st August. | | Eight Months ended 31st August. | | Month ended 31st August. | | | Eight Months ended 31st August. | | |
| | | 1862. | 1863. | 1862. | 1863. | 1862. | 1863. | Increase (+) or Decrease (−) | 1862. | 1863. | Increase (+) or Decrease (−) |
| | | | | | | £ | £ | £ | £ | £ | £ |
| Alkali: Soda ... ... ... | cwt. | 205,145 | 176,329 | 1,383,631 | 1,416,408 | 90,160 | 74,481 | − 15,679 | 583,359 | 589,169 | + 5,810 |
| Coal, Cinders, and Culm ... ... | tons | 853,314 | 773,167 | 5,543,874 | 5,445,134 | 385,470 | 336,666 | − 48,804 | 2,489,150 | 2,410,022 | − 79,128 |
| Iron, Pig and Puddled ... ... | " | 39,631 | 38,839 | 306,833 | 312,305 | 105,222 | 106,093 | + 871 | 820,360 | 850,442 | + 30,082 |
| Iron, Bar, Angle, Bolt, and Rod... | " | 25,343 | 29,956 | 198,355 | 214,572 | 186,385 | 222,875 | + 36,490 | 1,432,179 | 1,601,725 | + 169,546 |
| Iron, Railroad, of all sorts ... | " | 38,424 | 56,069 | 271,332 | 321,231 | 289,058 | 394,979 | + 105,921 | 1,889,641 | 2,246,129 | + 356,488 |
| Iron, Cast ... ... ... ... | " | 4,662 | 7,269 | 42,301 | 58,738 | 41,020 | 62,246 | + 21,226 | 365,694 | 489,534 | + 123,840 |
| Iron Hoops, Sheets, and Boiler Plates ... ... ... | " | 9,339 | 14,197 | 66,835 | 89,657 | 92,870 | 169,354 | + 76,484 | 654,181 | 1,033,129 | + 378,948 |
| Iron, wrought, of all sorts ... | " | 10,224 | 11,403 | 65,776 | 71,801 | 195,130 | 227,130 | + 32,000 | 1,280,527 | 1,378,212 | + 97,685 |
| Iron, old, for re-manufacture ... | " | 2,206 | 571 | 16,080 | 11,410 | 8,805 | 1,721 | − 7,084 | 62,396 | 42,620 | − 19,776 |
| Iron Steel, unwrought ... ... | " | 2,687 | 2,297 | 18,095 | 17,945 | 80,317 | 74,354 | − 5,963 | 587,660 | 581,728 | − 5,932 |
| Copper, unwrought, in Ingots, Cakes, or Slabs ... ... | cwt. | 12,477 | 24,393 | 68,784 | 186,894 | 58,902 | 114,089 | + 55,187 | 336,467 | 856,992 | + 520,525 |
| Copper, wrought or partly wrought, Bars, Rods, Bottoms, Pans, Plates, Sheets, and Nails; and mixed or Yellow Metal for Sheathing .. | " | 39,352 | 52,756 | 273,134 | 372,633 | 187,232 | 240,497 | + 53,265 | 1,278,508 | 1,697,708 | + 419,200 |
| Copper, wrought, of other sorts... | " | 2,448 | 1,234 | 16,770 | 6,802 | 13,888 | 8,474 | − 5,414 | 101,557 | 42,418 | − 59,139 |
| Brass of all sorts ... ... ... | " | 3,050 | 4,108 | 24,417 | 29,082 | 18,863 | 21,016 | + 2,153 | 132,926 | 145,125 | + 12,199 |
| Lead, Pig, Rolled, Sheet, Piping, Tubing, and Lead Shot | tons | 3,865 | 3,475 | 23,342 | 26,106 | 80,109 | 74,147 | − 5,962 | 494,221 | 562,336 | + 68,115 |
| Lead Ore, Lead, Red and White, and Litharge of Lead ... | " | 558 | 691 | 5,879 | 4,465 | 14,012 | 16,952 | + 2,940 | 131,678 | 107,280 | − 24,398 |
| Salt ... ... ... ... ... | " | 77,613 | 70,968 | 451,782 | 438,677 | 35,643 | 32,376 | − 3,267 | 218,851 | 203,331 | − 15,520 |
| Tin, unwrought ... ... ... | cwt. | 8,219 | 6,587 | 57,408 | 53,344 | 45,528 | 38,709 | − 6,819 | 332,690 | 313,551 | − 19,139 |
| Tin Plates ... ... ... ... | " | 89,173 | 85,744 | 729,618 | 753,081 | 109,758 | 101,522 | − 8,236 | 876,441 | 882,122 | + 5,681 |
| Zinc or Spelter, wrought or unwrought ... ... ... | " | 5,626 | 10,030 | 61,562 | 61,629 | 5,880 | 9,539 | + 3,659 | 60,944 | 60,286 | − 658 |
| | | | | | £ | 2,044,252 | 2,327,220 | + 282,968 | 14,129,430 | 16,093,859 | + 1,964,429 |

## MINERS' ASSOCIATION FOR CORNWALL AND DEVON.

The annual meeting of this Association took place in the Committee-room of the Royal Cornwall Polytechnic Society on September 16th, Mr. J. J. Rogers, M.P., in the chair. After a few introductory words from Mr. Rogers, the meeting was addressed by Mr. R. Pearce, Mr. Twite and Professor Hunt, detailing the operations of the Association. According to Mr. Hunt it appears that four classes have been added to the list since the last annual meeting, those of Camborne, Lostwithiel, St. Ives, and Tywardreath, and that there are several places in Cornwall and Devonshire anxious to have classes established. The funds of the Association, however, are not sufficiently flourishing to allow of this being done. Even at present their working expenses exceed the subscriptions they receive, and consequently, unless they get general support they cannot go on with that zeal and energy with which the work has been carried out during the past year. Mr. Hunt said that many gentlemen in the county had expressed themselves disposed when they saw the stamp of success on the Association to give it their support, and he hoped they would now come forward and help them. Mr. Hunt concluded by observing that up to the present time the officers and members of the Miners' Association had been fighting an up-hill game. They had been contending with prejudices of various kinds, which were slowly dying out; and if they could only work on he felt convinced that all the prejudices in their path would disappear, and that they would get the support which he believed they deserved.

The following papers were then read:—"On the boring machine now employed in making the tunnel through Mount Cenis,"* by Mr. Charles Fox; "On the tin mines of Spain," by Mr. R. Pearce; "On steam boiler explosions" and on "Surface indications of mineral deposits," by members of the Helston class, read by Mr. Hunt; and "On the gold mines of Aymayapampa," by Mr. M. Punnett.

## SOUTH WALES INSTITUTE OF ENGINEERS.

The annual general meeting of the members of this Institute took place at Swansea on September 26th, under the presidency of Mr. Thomas Evans, Government Inspector of coal mines for the South Wales division. The first paper read was by Mr. W. Firth, on coal cutting by machinery, in which he stated that, as there are diversities of opinion as to the practicability of so employing machinery with economy, a description of the machine, and statement of results of working, might throw some light on the subject. The motive-power (compressed air) is produced by means of a small horizontal engine placed on the surface, having a cylinder 20″ in diameter, 3′ stroke, connected direct with the blowing cylinder, 18″ diameter, and the same length of stroke. A receiver is placed outside the house, 30′ long and 3′ diameter, having a cubical capacity of about 288′. The steam is raised to a pressure of 35 to 40 lbs. to the square-inch; and 12 to 14 strokes of the engine per minute maintain a pressure of 55 lbs. per square-inch of air for three machines. The machine is constructed of angle iron, and is about 4′ long, 3′ 6″ high, and 2′ 6″ wide. The weight is about 14 cwts., including the small air-engine to work it. It is mounted on wheels, and is readily moved forward and backward by the attendant. The cylinder of the engine is 5″ diameter, and 12″ stroke, and the piston is connected with a crank attached to the vertical shaft, which carries the pick fixed in the socket. The pick is made very strong, and with a chisel point, to suit the work at our colliery, and can be readily removed in a few minutes. The pick socket is fitted to the shaft, for adjustment to any

* See *Mining and Smelting Magazine*, vol. ii, p. 129.

height between the floor and roof of the seam, so that the holing can be effected at an intermediate point. The motion of the pick follows that of the human action, and either a double or single headed pick may be used; the former, however, takes up more width in working than the latter. The strength must be proportioned to the work, and the length of the head to the depth of the holing. A width of about 3′ is maintained between the front row props and the stall face for the passage of the machine in holing. The road is formed with strong rails, so as to avoid springing when the machine is in action. The system of working is by long wall; but until recently the stalls have only been 40 to 45 yards long open, which has been a considerable disadvantage in applying the machine, as it is found that one machine holes 100 yards per shift of 8 hours 3 ft. under. The middle piece of coal between the two partings, or bands, is holed about 2′ 6″ from the roof, and 1′ 4″ from the floor. The coal is tender, but contains a large quantity of hard pyrites, which is destructive to the points of the hand pick; but from the more solid form and size of the machine tool, there is much less difficulty in making it stand the work, and the cost of repairs is considerably less, being about one-eighth the cost of hand tools. The holing (3′ under) is accomplished in three courses or lifts—*i. e.*, the machine is passed thrice along the face to hole this distance under—the first holing is 16 to 18″ wide, the second 10 to 11″ and the third 8 to 10″ deep, a change in the cutting arm or pick being necessary at the end of each course. When a course of lift is finished, the machine is taken back to the starting point for the next lift, which occupies about two or three minutes, the only change being the cutting arm or pick. The time occupied in cutting the three lifts averages about one minute for every lineal foot of 3′ deep. In strong coal this depth can be worked by cutting away only 3 to 4″ in height at the face. A man and a boy attend the machine, and a man looks after the road and propping of the stall face.

The machinery is very simple, and little liable to derangement: nor are the working casualties more numerous than those of working any other machinery. The following are the results of working one machine six days of eight hours each, and including stoppages:—618 yards were holed 3′ under, which is more than 100 yards per day. The cost of labour attending machine, removing holing refuse, and attending surface engine, is $1\frac{1}{2}d.$ per ton on coals raised. One penny per ton will amply cover wear and tear of machinery, interest and redemption of capital on a daily get of 500 tons. The produce of large coal is also satisfactory, as the following figures show:

| | Got by Machine. | By Manual Labour. |
|---|---|---|
| Best Coal .. .. .. .. | 27·78 | 17·70 |
| Seconds ditto .. .. .. .. | 36·90 | 46·00 |
| Small ditto .. .. .. .. | 35·62 | 36·30 |
| | 100 | 100 |

The benefit in produce by holing with the machine is equal to $2\frac{1}{4}d.$ per ton on the gross get. The sanitary aspect of this question cannot be overlooked. The diminution in the number of men and burning lamps must render the atmosphere of the mine less vitiated. The discharge of a considerable quantity of pure air into the working places, in addition to the ventilation, will impart a more healthy condition to the atmosphere. The command of a powerful stream of air under a pressure of 50 lbs. per square inch will be useful in removing accumulations of explosive gas, which might not be removed by the ordinary current of air. It is said that upwards of 40 °/₀ of the loss of life in coal mines arises from falls of coal and roof. The introduction of machinery will reduce the number of persons exposed to these casualties at least by one-half, and, consequently, a considerable

saving in life will result. Having in view the facility for opening new works, and the ready means at all times for an increased power of production under sudden demand, caused by unusual seasons or other circumstances, and when the prices of coal are more profitable, the increased yield of large coal in the diminished quantity broken in hewing when compared with manual labour—all these and some other reasons warrant me in expressing a very confident opinion in favour of the introduction of machinery to coal cutting. The cost of compressed air power is undoubtedly great as compared with that of steam; but, nevertheless, when its advantages are put into the scale against the disadvantages of the old system, that cost becomes insignificant and immaterial.

Mr. Lionel Brough said that there could be no doubt that, under the circumstances which now prevailed, a coal-cutting machine would be a most desirable thing; but the question then arose what sort of one. He believed the best one which had been exhibited up to the present moment was that of Preece's, which appeared to be a kind of mechanical mandril or pick. Now, how far such could be applied to all sorts of seams is a question of great moment, and one worthy the consideration of engineers and colliers generally. In very inclined stratifications he could hardly conceive how such a machine would suit. Again, he had heard it stated that so terrible was the blow struck by this powerful mandril, impelled by the force of compressed air, that some of the strokes produced streams of fire, probably by striking against pyrites or particles of siliceous matter. Now, if streams of fire, or even sparks, were produced, he should not like to apply the machine in the fiery seams of South Wales. Again, they did not at present know how to apply the engine to nicking or cutting; if the machine would only hole he thought they may as well be without it. For his own part, he could only see that the machine would be productive of good when applied to long work in stalls, and apprehended that a piece of moving machinery would occupy so much space as to interfere with the speed and despatch of removal of coal.

Mr. Bedlington said they had seen by the description of work which this machine was capable of doing that it was simply holing; he did not think it had been stated by any one that cutting was done as well. Now, they all knew, that holing was but a very small part of a collier's labour, and was very little required, especially in long work, where there was a good deal of pressure on the face of the coal. Now, if the machine was for holing only, it would be but of very little assistance indeed, for, even with the machine in work, they must have a man to block down the coal, to fill the coal, and to cart the rubbish, just as before, so that there would be but very little assistance given in cutting and filling the coal. Then, again, they would have to be constantly removing the machine from one stall to another, and he did not know how many machines they would not require in an extensive colliery, so as to be of any service. So far, therefore, as he had read the descriptions of the various machines, he thought there was very little to be got out of them, as far as the saving of labour was concerned, and that, after all, was the great item. They would have to leave a great deal of room open when the machine was at work, and there would be a great deal of difficulty in keeping up the roof when they came to a fault.

Mr. Birkbeck had seen the machine at work and did not think it could be advantageously applied to anything but long-wall. It could, no doubt, be applied with advantage in some veins; but there were other veins where it could not become general, and especially those of South Wales.

Mr. Lionel Brough said this matter was one of the deepest importance, not only to the mining engineers and colliers of South Wales, but to the whole mining world at large, and therefore it would be well to begin at the beginning. In the working of collieries they must have either muscular

power or mechanical power, and the simple question was, which was the best. In the present instance he believed they had discovered the right power, and a step has evidently been taken in the right direction, by making use of compressed air as the motive power. In fact there was no other power which could be used—steam was unsuitable, and water would be detrimental to the collieries, and would have to be pumped up again, and therefore compressed air was the proper power for the purpose. The first grand step had been arrived at—"the power." This being the case, the next step would be to get some patriotic liberal-minded colliery proprietor to get a machine fitted up in one of his pits in South Wales for two or three months, and give access to all the colliery miners and engineers of the district; and if they had this advantage afforded them they would then be able to arrive at some satisfactory conclusion as to the adaptability of the machine for this district; and he therefore hoped some of the gentlemen present would represent to the colliery proprietors and wealthy owners the very great advantages of giving one of these machines a fair trial in this district.

Mr. T. F. Brown said that coal cutting by machinery had been found to answer very well where it had been used; but in his opinion the introduction of machines into the collieries of South Wales would be practically impossible. The great majority of the seams were only about 3′ thick, whereas the machine would require about 6′ of room. Again, Mr. Brough had stated that the pick was very likely to strike fire; if this was the case it would light up the gas, and they would be exposed to more danger than they were at present, and they all knew they were exposed to quite enough now. Then again, as regarded the expense, he believed that in this district, even with the machine worked in the most economical manner, they would find that manual labour was, after all, the cheapest. Machinery might be advantageously employed in other parts; but his opinion was that coal cutting by machinery in South Wales was a long way off—that, in fact, it would never answer, either as applied to long wall, short wall, or the old system of pillar-and-stall.

The other papers read were:—A description of a mode of sinking a pit through quicksand, by Mr. Glassbrook; On surface condensation and the use of distilled water in boilers, by Mr. Turner; Long-work, by Mr. John Williams; and On coal and ironstone mining in Scotland, by Mr. R. Moore. The President also read a letter from Mr. Adams, who had forwarded some samples of iron made with coal from the eastern out-crop of the South Wales basin. The President stated that he alluded to this matter now, because in a paper given by Mr. Child at the last meeting, something was said about the manufacture of iron from the raw coal, and it was said that "in the eastern part of the South Wales coal-field the coals were too bituminous, that is, of too coking a nature to be used raw in the blast-furnace." Mr. Adams had sent them a practical reply to that statement by forwarding them samples of iron made from the rock-vein coal.

Mr. Richards said the sample produced had been manufactured under his supervision, and he had watched the working of the furnace very carefully, and great care had been taken in making the samples. Iron had been made in various ways, with coke, with coke mixed, and raw coal. There had been no irregularity whatever in the working of the furnace. There had been no difficulty in using raw coal in Abersychan. They were particularly anxious to ascertain the fact of iron being made from the raw coal, and the fact now lay before them. He assured them that there was no difficulty in using this coal, which was the rock-coal, and he was surprised to see it working so well, and coming out of the furnace so regularly.

The President said it was not only Mr. Child, but several other gentlemen who were of opinion that the coal of the eastern basin was not adapted for smelting purposes.

# Current Notes and Memoranda.

Association for the Prevention of Steam Boiler Explosions.—At the monthly meeting of this association, on September 29th, Mr. Fletcher reported that during the past month 319 engines and 471 boilers had been examined. Of the latter, five were found to be fractured, two dangerously; sixteen in a state of corrosion; two safety-valves out of order; and one furnace was out of shape. Three boilers, not under the inspection of the association, had exploded during the month, from which four persons were killed and three injured. One explosion was entirely attributed to a defective plate in the fire-box, which had been eaten away by corrosion until reduced to one-sixteenth of an inch in thickness. Mr. Fletcher's report concluded with an earnest recommendation to adopt the precaution of having all boilers subjected to the hydraulic test.

Lighting of Coal Pits.—A new method of illuminating fiery collieries has been proposed by MM. Dumas and Benoit, and which they say, so far as their experiments have gone, gives promise of success. In effect, the method consists in supplying each pitman with a "Geyseler Tube," in place of a Davy lamp. The light within the tube is produced from a Rhumkorff's coil, placed at a distance from the face of the workings. Insulated wires lead from this to each of the illuminated tubes, which can as easily be moved about as a Davy lamp, and as the tubes are hermetically sealed there is no possibility of ignition of the explosive gases. The light obtained, they admit, is feeble, but this they expect to improve upon.

Manufacture of Iron.—Mr. J. Cameron has obtained a patent for improvements in the manufacture of iron and its alloys (specif. 342), in effecting which any ore of iron is taken either calcined or uncalcined according to the nature of the ore; the proportions of other materials present are ascertained by chemical analysis, and for every equivalent of silica there is added one equivalent of lime or any other suitable flux. Next, after having ascertained by analysis the quantity of oxygen present in the ore, there is added one equivalent of carbon to take up the oxygen of the ore; the quantity of silicious matter present in the carbonaceous matter mixed with the ore is then ascertained, and sufficient flux is added to combine with it. The whole is intimately mixed and ground together by edge rolls or other suitable apparatus, sufficient water being added from time to time to reduce the mixture to a pasty state, so that it may be cast into blocks. The blocks are partially dried either by compression or heat, and are then taken to a cupola blast or other suitable furnace, and subjected to heat till the result is a pure metal. By this process a purer metal is obtained than by the methods hitherto employed, whilst a saving of fuel is also effected.

Machine for Crushing Quartz.—Messrs. Williams and Price propose an improved machine for crushing and amalgamating auriferous quartz, and pulverising and washing ores (specif. 355). The quartz is crushed by means of an iron cylinder mounted horizontally in bearings at each end, inside of which are placed balls, and the cylinder is caused to revolve by suitable gearing. The inner surface of the cylinder is connected, or has alternate ridges cast upon it, so that upon its being set in motion the ball is carried a little distance round with the cylinder, until the centre of gravity of the balls falls outside the projecting rib or ridge, when it immediately rolls over the temporary obstruction, and adds the effect of a blow to the simple weight of the ball, which greatly increases its crushing or pulverising power. Mercury is also introduced into the cylinder with the quartz, by which the metal contained in the quartz is amalgamated with the mercury during the process of crushing.

Treating Products obtained from Coal.—Mr. J. J. Müller, of Basle, proposes to treat with lime the heavy oils obtained from coal tar. There is a great difficulty in obtaining a satisfactory result from this process, unless the right proportions are taken to produce a homogeneous mass of phenate of lime. It has, in fact, been considered practically impossible to treat the heavy oils with lime in the same way that they are treated with caustic potash, or soda, and for that reason it is considered that this method offers great economy over the old process. The dead oil is allowed to stand for a few weeks until the naphthaline has become separated by crystallisation. Of the oil thus prepared take 100 kilogrammes, and mix therewith in a suitable vessel from about 6 to 7 kilogrammes of milk of lime, the milk of lime being made in the proportion of 2 kilogrammes of lime to 15 kilogrammes of water. This mixture is to be kept well stirred until the lime is quite dissolved, and it is then allowed to rest for from two to three days. A phenate of lime thus obtained, which, by reason of its specific gravity, settles at the bottom of the vessel, is then to be decanted from the light oils. The solution of phenate of lime being clear is now placed in a suitable vessel and saturated by an acid in the way that is now generally practised. It is preferred to use muriatic acid, which combines with the lime, forming therewith a soluble salt. The phenic acid thus obtained, which is easily separated from the muriate of lime by decantation, is distilled over for purification. A second distillation will produce crystallised phenic acid. It should be remarked that it is very important to use the dead oils as free as possible from naphthaline, and that for this reason the naphthaline is removed, as above explained, before applying the milk of lime.

A Substitute for Coal.—There is in Trinidad, only a mile from the coast, a basin of 90 acres filled with asphalt, yielding 70 gallons of crude oil per ton. There are also springs of asphaltic oil in the neighbourhood, and large pitch banks off the shore. It is estimated that the lake is capable of producing 300,000,000 gallons of oil, and 40 or 50 gallons are considered equal to a ton of coal. The *Trinidad Colonist* publishes a *mémoire* by Mr. Stollmeyer, of Port of Spain, proposing the use of this liquid fuel for oceanic steam navigation, and he states that he has been at various times for these three years suggesting this employment of a distillate from the pitch lake of Trinidad. To oil a ship would not take above a tenth of the time it takes to coal her if pipes were employed, and the oil would not take above a fourth of the space occupied by coals. He recommends that it be applied at once as auxiliary to coal by throwing jets over the burning mass, but contemplates eventually upright tubular boilers, the liquid fuel to be applied as fast as it can be converted into flame. Of course the North American oil springs are another source of supply.

Production and Generation of Gas.—Mr. J. C. Jeffcott has patented some improvements in the production and generation of gases, and also in apparatus connected therewith. The object sought to be obtained is that of utilising the heat not used, or which escapes without being used, in steam or other furnaces and fire-places of every description. The means to do this consists of introducing into the furnaces vessels of various forms, according to the construction of the furnaces, so as that the heat may be used; these vessels must correspond with the form of the furnaces now in use. The form to be generally used will consist of a retort placed lengthways, or as may best suit the fire-bars of the different fire-places, and which will have mouth-pieces so as to be air-tight, through which are to be introduced the animal or other substances from which the different gases are to be obtained by their cohesiveness being destroyed by the heat before referred to, and not hitherto used for this purpose. The gases after being set free in the retorts are then conducted by pipes in the way usually done, and applied to the different purposes for which they are now used. He likewise claims to be the inventor of a new description of furnace, to be

entirely composed of wrought or cast metal, which consists of a fire-place, with fire-bars on which the combustibles or heating substances are to be placed, and retorts for holding the materials rich in gases: these retorts to have the mouth-pieces for introducing the substances to be used, and then another casing to be placed over the whole, so that the heat may be prevented from escaping when the gases are disengaged.

## Patents relating to Mining and Metallurgy.

*(Compiled from Commissioners of Patents' Journal.—Subject matter only given.)*

APPLICATION FOR PATENTS FROM SEPT. 22ND TO OCT. 19TH.

2334 (1863). G. M. DE BAYELT and J. E. PIGOULETE, Agglomerating fuel.

2357 (1863). J. STURGEON, Machinery for boring coal and rocks.

2359 (1863). A. V. NEWTON (com. from A. NOBEL), Improvements in blasting powder.

2398 (1863). G. ELLIOT, Improvements in props and supports for coal mines.

2425 (1863). E. B. WILSON, Improvements in manufacture of iron and other metals, and in the apparatus employed therein.

2477 (1863). G. PARRY, Improvements in refining crude pig-iron.

2482 (1863). R. MARTYN, Condensing and purifying the fumes and gases arising from the treatment of metals and metallic ores and substances.

2483 (1863). R. A. BROOMAN (com. from H. W. ADAMS and W. S. WORTHINGTON), Amalgamating and separating gold and silver from quartz.

2485 (1863). J. VAUGHAN, Apparatus for purifying waste gases from blast-furnaces.

2502 (1863). C. HUMFREY, Improvements in purifying hydrocarbons.

2549 (1863). E. H. C. MONCKTON, Improvements in the means of joining plates or sheets of metal.

2558 (1863). W. CLARK (com. from J. J. BONNARD), Improvements in separating ores from their gangues, and in apparatus for the same.

NOTICES TO PROCEED FROM MAY 21ST TO AUG. 21ST.

1278 (1863). E. SONSTADT, Manufacture and purification of the metal magnesium.

1297 (1863). J. S. BICKFORD and G. SMITH, Manufacture for firing explosive compounds.

1502 (1863). F. S. WILLIAMS (com. from E. WHEELER), Apparatus for shaping plastic materials and hot but not melted metals by pressure.

1331 (1863). H. C. COULTHARD, Improvements in blast-engines.

1431 (1863). C. NICQUET, Apparatus for sorting and washing ores.

1470 (1863). G. BEDSON, Improvements in cupolas and blast-furnaces.

1704 (1863). J. THOMAS, Treating ores and earths containing iron, and obtaining metal from them.

2080 (1863). R. GRIFFITHS, Construction of retorts for extracting oil from cannel coal and other bituminous substances.

PATENTS SEALED FROM SEPT. 25TH TO OCT. 16TH.

815 (1863). J. DALE and G. BISCHOF, Manufacture of aniline, naphthylamine, and other analogous bodies.

841 (1863). W. MITCHELL (com. from J. MITCHELL), Improved process for coating iron.

924 (1863). J. RAMSBOTTOM, Machinery for hammering, rolling, and shaping metals.

878 (1863). R. A. BROOMAN (com. from J. G. L. BURNET), Manufacture of

baryta and its derivatives in obtaining by-products, and in revivifying or recovering certain agents employed in such manufacture.

891 (1863). A. KINDER, Coating lead or its alloys with tin or its alloys.

1072 (1863). G. E. DONISTHORPE, Apparatus for getting coal.

1613 (1863). R. MUSHET, Improvements in manufacture of iron and steel.

1980 (1863). A. V. NEWTON (com. from T. ALLIN), Process for hardening cast-iron.

1987 (1863). R. MUSHET, Improvements in the manufacture of cast-steel.

920 (1863). W. CLARK (com. from L. N. LANGLOIS), Improvements in separating ores from their gangues.

956 (1863). J. BAGGS and W. SIMPSON, Purifying and treating coal gas and sulphuretted hydrogen, and in obtaining sulphur, sulphuric and other acids in such treatment.

972 (1863). C. W. and F. SIEMENS, Improvements in smelting-furnaces.

1115 (1863). J. H. JOHNSON (com. from A. MUELLER), Manufacture of wrought-iron and steel.

1242 (1863). H. BENNETT, Apparatus for puddling iron.

1012 (1863). T. RICHARDSON and J. C. STEVENSON, Improvements in the manufacture of sulphate of soda.

1089 (1863). W. CLARK (com. from L. J. F. MARGUERITTE), Manufacture of hydrocyanate of ammonia, and alkaline and earthy cyanides.

1147 (1863). J. B. P. A. THIERRY, Improvements in the construction of furnaces.

1420 (1863). J. G. JONES and R. RIDLEY, Machinery and apparatus for working coal and other mines.

PATENTS ON WHICH £50 DUTY HAS BEEN PAID, FROM SEPT. 24TH TO OCT. 17TH.

2368 (1860). A. WARNER, Manufacture of iron, steel, copper, lead, tin, and their alloys, and in the manufacture of coke.

2338 (1860). F. W. DAEHNE, Improvements in extracting copper from ores.

2390 (1860). J. and D. F. BOWER, Manufacture of cast-iron and steel.

2544 (1860). A. V. NEWTON (com. from P. HANNAY), Improved machinery for crushing quartz.

2654 (1860). W. E. NEWTON (com. from L. LE CHATELIER), Production of alumina and salts of alumina.

2525 (1860). W. HENDERSON and J. DOWN, Obtaining copper, silver, tin, and other metals from their ores, or other natural or artificial compound containing them.

2552 (1860). J. THOMPSON, E. G. FITTON, and F. A. FITTON, Machinery used in boring, turning, and cutting metals.

PATENT ON WHICH £100 DUTY HAS BEEN PAID, SEPT. 29TH.

2476 (1856). W. E. NEWTON, Machinery for rolling and forging iron or steel.

PATENTS BECOME VOID BY NON-PAYMENT OF DUTY, FROM SEPT. 19TH TO OCT. 17TH.

2216 (1860). G. DAVIES (com. from J. CAZANAVE), Improvements in the processes of cementing iron.

2253 (1860). J. HANSOR, Improvements in the manufacture of coal gas.

2272 (1860). R. REECE, Obtaining products from lignite and certain bituminous mineral substances.

2218 (1856). W. TAYLOR, Conversion of cast-iron into steel and malleable iron.

2239 (1856). W. BEATSON, Improvements in puddling iron.

2334 (1856). H. MACKWORTH, Separation and treatment of mineral substances.

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## AUSTRIA.

PATENT DELIVERED JULY 20TH.

353 (1863). F. KISZ, Extracting gold and silver from ores, slick, and metallurgical products.

## FRANCE.

### Current List of Patents.

57,752 (1863). Calixte-Mineur, Improvements in the construction of puddling and reheating furnaces.
57,784 (1863). Cumin, Manufacture of malleable pig-iron.
57,797 (1863). Mueller and Co., Manufacture of zinc in blast-furnaces.
57,877 (1863). Coates, Improvements in the treatment of white oxide of zinc.
57,881 (1863). Delin, Rolling wires of iron, steel, and brass in a cold state.

## UNITED STATES.

### Patents issued from Aug. 18th to Sept. 29th.

39,550 (1863). E. Coleman, Improved machine for amalgamating precious metals.
39,607 (1863). S. L. Wiegand, Distillation of oils and paraffine from peat and other substances.
39,625 (1863). W. Blake, Improvements in retorts for refining zinc.
39,684 (1863). M. W. Tinding, Improvement in treating pyritous and other sulphur ores.
39,786 (1863). L. G. Marshall, Improvement in furnaces for desulphurising ores.
39,898 (1863). J. C. Dickey, Improvement in quartz crushers.
40,103 (1863). A. Hitchcock, Improvement in quartz crushers.
40,116 (1863). A. Monnier, Separating copper, nickel, and cobalt.

## SPECIFICATIONS PUBLISHED, AND PRICES.

### From Sept. 26th to Oct. 24th.

365 (1863). M. Cartwright, Combining plastic substances with metals; 4*d*.
385 (1863). G. H. Birkbeck (com. from M. C. Roswag), Separating silver or other metals from lead; 4*d*.
388 (1863). J. Jones, Manufacture of lead, tin, &c.; 8*d*.
450 (1863). J. Gray and J. Hudson, Treating and applying steatite; 4*d*.
485 (1863). W. H. Gauntlett, Blast-heating apparatus; 4*d*.
501 (1863). G. Davies (com. from J. F. Stileman and Z. Ellis), Smelting furnaces; 8*d*.

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# Trade Review of Mining, Quarrying, and Metallurgy.

## WESTERN COUNTIES.

Mining in Cornwall has decidedly improved during the past month, and a much more cheerful tone prevails. This is, of course, in a great measure due to the extraordinary rise in the copper standard, which has advanced upwards of 7*l.* This will have a most beneficial effect, and will go far to compensate for the comparatively small production of this metal in the county at present.

At the last sitting of the Stannaries Court, Mr. William Gundry applied for an order to inspect East Caradon mine on a day other than Wednesday. The object of the application was to question the validity of a resolution of a general meeting of the shareholders, limiting the time for permitting the inspection of the mine on behalf of any particular shareholder to the first Wednesday in each month. The order was refused with costs, the Vice-Warden grounding his judgment on the general principles of the superior Courts of Equity, that where partners have agreed that the management of their affairs shall be intrusted to one or more of them, as was the case in this instance, the court will not interfere with them, unless they are clearly acting illegally, or in breach of the trust reposed in them.

The lead smelting works at Swanpool, near Falmouth, which were erected three or four years ago in connection with the working of the Swanpool mine, have recently been resumed by a private limited liability company, under the management of Messrs. Phillips and Darlington. The works are not far from the line of the Falmouth railway, with which they may be ultimately connected.

An important discovery has been made in *New Rosewarne*, where they are reported to have a lode in the shaft worth 120*l.* per fathom. This sett was originally the old part of Rosewarne United, and was abandoned some few months ago by the adventurers of that mine by the advice of Capt. Thomas Richards. At *Sithney Carnmeal* they have an improvement in the bottom of the mine.

At *Clifford Amalgamated* the discoveries in the middle and western parts of the mine are reported to be very encouraging. At *South Frances* a good lode of tin is said to have been discovered in the 114 west. *Prosper United* is reported to be looking very promising, and several important points in the mine are said to be turning out well.

At *Drake Walls* meeting (on Sept. 24th), it was resolved that the committee be authorised to contract for the sale of West Drake Walls sett, and to sell it for 160*l.* At *Creegbrawse* meeting (on Sept. 25th), it was resolved to erect an engine forthwith. At *West Stray Park* meeting (on Oct. 14th), it was resolved that a new engine shaft be commenced on Wheal Frances lode, and an engine erected thereon. At *South Carn Brea* meeting (on Oct. 20th), it was resolved that the committee be respectfully requested to remove Capt. Glanville from the chief agency at the mine, and to appoint another in his place, suggesting Capt. Daw as a suitable person.

## WALES AND THE BORDERS.

SOUTH WALES.—The iron trade has been much more active in consequence of the masters being so well supplied with orders; and it is expected that many of the furnaces standing idle will shortly commence working. Buyers have shown no disinclination to the advanced prices, and it is hoped that the trade will continue in this satisfactory state throughout the winter months, though some are of opinion that this will not be the case, but there is no reason for any falling off, as the export trade has greatly increased of late, and a good demand has set in from Russia, whilst Italy continues to receive large supplies of Welsh iron. The ironmasters have agreed to make an advance of about 10 °/₀ in the wages of their workmen commencing on November 1st, and this decision has been cheerfully received. It is hoped that the advance will be the means of putting a stop to the emigration, which still continues unabated, and is causing a great scarcity of hands.

At the beginning of the war in America, the tin-plate makers suffered greatly, as their trade was carried on chiefly with that country, but during the last twelve months, some improvement has taken place, and several of the works which had been altogether stopped have recommenced operations. The following is a list of the South Wales tin-plate works:—

| Situation. | Name of Proprietors. |
|---|---|
| Carmarthen .. .. .. .. | Matthew Wayne. |
| Kidwelly .. .. .. .. | Not occupied. |
| Morfa (Llanelly) .. .. .. | J. S. Tregoning and Co. |
| Dafen .. .. .. .. .. | Phillips, Smith, and Co. |
| Swansea .. .. .. .. | Davies and Sons. |
| Landore (Swansea) .. .. .. | Landore Tin Plate Co. |
| Upper Forest (Llansamlett) .. .. | W. Hallam and Co. |
| Lower Forest .. .. .. .. | Jenkins and Co. |
| Ynispenllwch .. .. .. .. | Henry Stuck and Co. |
| Pont-an-Tawe .. .. .. .. | Wm. Gilbertson and Co. |
| Ystalyfera .. .. .. .. | Ystalyfera Iron Co. |
| Aberdulais (Neath) .. .. .. | Jos. Williams and Co. |
| Ferry (Briton Ferry) .. .. .. | Smith, Morris, and Co. |
| Margam .. .. .. .. | Margam Tin Plate Co. |
| Cwm Avon .. .. .. .. | Governor and Co. |
| Machen .. .. .. .. | Woodruff and Co. |
| Tydu .. .. .. .. .. | Lewis and Co. |
| Pontymister .. .. .. .. | Banks Brothers. |
| Caerleon .. .. .. .. | Jenkins and Co. |
| Pontrhydyrun .. .. .. | Conway, James, and Co. |
| Pontypool .. .. .. .. | Darby and Co. |
| Abertillery .. .. .. .. | Price and Co. |
| Abercarne .. .. .. .. | Whitehouse and Co. |

The coal trade has considerably improved within the last month, and would be even greater, but for the scarcity of vessels. It was resolved at the Cardiff meeting to advance the price of steam coal 1*s*. per ton, and the wages of the colliers from 5 to 10 °/₀, according to the nature of the coal worked. The coal masters are overstocked with orders, and the colliers have taken advantage of this, and, instead of working the daily quantity, turn out less coal than usual, in order to secure a larger advance than what has been promised them.

An explosion took place on Oct. 17th, at the Morfa Colliery, by which thirty-nine lives have been lost. The pit in which it occurred is one of the largest in South Wales, and the whole of the works are stopped in consequence of the explosion. An accident has also occurred at the Dowlais ironworks on Oct. 13th, by which one man was killed and two others seriously injured.

It is said that the Tyne and Clyde shipbuilders are likely to meet with much opposition from the Welsh ports, the Newport Wood and Iron Shipbuilders Company having purchased an extensive shipbuilding yard at Newport with the view of building iron ships, and it is believed that from the advantages of the situation, they will be able to compete successfully with the Tyne and Clyde shipbuilders.

During September 365 vessels cleared the port of Cardiff, and the exports amounted to 137,012 tons of coal, 9,668 tons of iron, and 1,961 tons of coke, showing an *increase* of 733 tons of coal, and a *decrease* of 7,431 tons of iron, compared with the corresponding month last year. This will show that the coal trade of Cardiff continues to progress.

The trade of Neath and Briton Ferry has suffered somewhat on account of the adverse winds during the last month. The exports were—24,274 tons of coal, coke, and culm; 849 tons of bar-iron; 245 tons of tin plates, and 89 tons of copper, whilst the imports were 7,198 tons of iron ore, 3,126 tons of copper ore, and 1,255 tons of pig-iron. The number of ships entering the harbour was 242, with a registered tonnage of 20,004, the burden tonnage being 31,253.

The number of vessels engaged in the trade of Swansea during September was 423, with an aggregate registered tonnage of 51,653 tons, and the shipping rates received amounted to 1,392*l.* 19*s.* 2*d.* The falling off in the number of vessels was occasioned by the unfavourable weather which prevailed. The arrivals during the month include:—copper ore from Cuba, Aveiro, Caldera, Genoa, Havre, Coquimbo, Chaneral, Paposo, and San Sebastian; zinc ore from St. Malo; copper regulus from Huesco, Nantes, and Coquimbo; spelter from Hamburg; and iron ore from Cherbourg and Santander.

GLOUCESTERSHIRE.—The imports into Bristol include:—294 tons of sulphur ore from Arklow, and 150 tons from Pomaron; 145 tons of sulphur from Gargenti, and 26 tons from Liverpool; 775 tons of pig-iron from Glasgow and Belfast, and 300 pieces from Archangel; 40 tons of tin plates from Newport; 1 ton of block tin, 16 casks of lead ore, and 30 tons of iron ore from Liverpool; also 68 tons of lead ore from Newquay; 75 tons 18 cwt. of silver lead ore from Plymouth, and 90 tons from Workington; 4,211 pieces of zinc from Stettin; 25 tons of bar iron from Bridgwater, and 200 tons of lead from Alicante. The exports include:—860 tons of coal and nearly 62 tons of iron. 801 tons of coal and 3,545 tons of iron were exported oversea from Bristol during the month of September, against 295 tons of coal and 3,236 tons of iron in August, showing an *increase* of 506 tons of coal and 1,309 of iron. During the quarter ending September, 1,862 tons of coal and 9,065 tons of iron were shipped at Bristol for foreign ports, being a *decrease* of 709 tons of coal, but an *increase* of 3,012 tons of iron compared with the exports of the corresponding three months last year. The customs' duties received during the month amounted to 103,387*l.* 8*s.* 2*d.*, and 87 vessels entered with cargoes from foreign ports, whilst 15 vessels cleared outwards with cargoes.

Among the imports into Gloucester have been:—998 tons of sulphur from Pomaron; 262 tons of iron from Ardrossan, 100 tons from Glasgow, and 70 tons from Swansea; 50 tons of pig-iron from Swansea; 339 tons of coal from Saundersfoot, 40 tons from Lundshipping, 80 tons from Bunz Port, and 80 tons from Llanelly. The exports comprised 982 tons of iron, and 6 tons of coal.

NORTH WALES.—The *Llanberis Slate Company* has issued a prospectus. The capital is to be 50,000*l.*, in shares of 5*l.* each. The *Golden Shoe Lead Mining Company* is divided into 3,200 shares, upon which 10*s.* per share is to be paid immediately. The *Cwt-y-Bugail Slate Quarry Company* has also issued a prospectus. The capital is to be 50,000*l.*, in shares of 50*l.* each.

The property proposed to be worked is the slate quarry of the same name, on the Blaen-y-Cwm estate, Festiniog.

## MIDLAND COUNTIES.

STAFFORDSHIRE AND WARWICKSHIRE.—The rise of 1*l.* per ton on iron has not checked the demand, indeed a large increase of trade may be anticipated. It seems to be a question as to whether the advance in price will be maintained or not, but upon the whole the prevailing tone is decidedly cheerful. Many of the makers of pig-iron have sold their entire stock. Messrs. Schneider and Hannay are reported to have sold as much as 70,000 tons, there being a very large demand for iron from the various shipbuilding yards of the kingdom.

The quarterly meetings of the ironmasters have been held during the month. At the Wolverhampton meeting, on the 7th, the attendance was good, but there was comparatively little business done, the bulk of the ordinary transactions of quarter-day being reserved for the Birmingham meeting. The tone of the assembly was such as to indicate that the trade is in a satisfactory state, an opinion being very confidently expressed that the recent advance in prices will be maintained. Be this as it may, no decisive check has been experienced since the rise of 20*s.* per ton was imposed, the only indication of it being an apparent reluctance on the part of home consumers to order except to a moderate extent. But against this it must be noticed that American orders are coming in—that the consumption of iron at this moment is in one way or other unusually large, and some of the principal makers have orders which will occupy them until nearly Christmas to execute. A large London buyer stated that some of the second-class makers have been asking the trade prices, a very unusual occurrence. But beyond the actual demand, a circumstance which must tend to keep up prices is the scarcity of labour which is felt both in the iron-works and in the collieries, so that, although there are works which are capable of producing a great quantity of iron, men are not to be had, and at some of the furnaces there is a partial stoppage from the want of under hands. In pig-iron the transactions were moderate, many consumers having bought at lower prices than at present prevail. Best hot-blast all-mine pigs are from 3*l.* 15*s.* to 4*l.*; exceptional makes are quoted 2*s.* 6*d.* higher. Cold-blast pigs are selling at 5*l.*, and hematites are now at 3*l.* 15*s.* to 3*l.* 17*s.* 6*d.* Ironstone of the district is in good demand; gubbin is at 15*s.* 6*d.* to 16*s.* per ton.

At the Birmingham meeting, on the 8th, there was a good attendance. The transactions were not large, but most of the producers of finished iron are well supplied with orders, and consequently no disposition to press for others; the fresh contracts entered into were at the full trade prices, none of the leading makers being disposed to accept below the rates fixed at the preliminary meeting, and the second-class houses are obtaining better prices in proportion than is usual. It was mentioned, too, that the works are all in full operation; where such is not the case it arises from a difficulty in the way of procuring labour, or in some other respect on that account. With reference to pig-iron the prices are not quite so well settled as they are for the manufactured article; the pig-masters ask about 3*l.* 17*s.* 6*d.* to 4*l.* per ton for good hot-blast mine iron, but consumers concede it reluctantly, and many of them are in a position to abstain from purchasing, having stocks of pig bought at low prices; moreover there is the competition with the inferior makes of pig-iron of Northamptonshire and the North, which is being pressed into this market at fully 5*s.*, perhaps 7*s.* 6*d.*, below the price of the pig-iron of this district. If, however, the demand for finished iron keeps up, Staffordshire pig will readily command the price above quoted. The trade in Shropshire pig-iron is steady, and

prices have advanced in proportion to the rise in the price of pig-iron, the produce of this district. In reference to the North Staffordshire iron it may be noticed that the advances in the price recently made will place the general scale relatively higher than it is in South Staffordshire.

At the Dudley meeting, on the 10th, the attendance was small, and scarcely any business was done. The transactions were almost exclusively in pig-iron, the prices asked by the pig-masters being more readily assented to than at the first assembly at Wolverhampton. For plates and hoop-iron there is a good demand, all who are in that department of the trade being well engaged. The coal trade in this district is becoming brisk, there being no apparent check by reason of the recent advance in the price. The demand for consumption at the works is steadily increasing. There is a steady and increasing demand for ironstone, the yield of the district; gubbin fetches fully 16s. per ton. There appears, also, to be a larger quantity of red ore coming into the district.

## NORTHERN COUNTIES.

NORTHUMBERLAND AND DURHAM.—The coal trade continues to improve, but has been somewhat checked by the scarcity of ships and the consequent highness of freights. The pits are once more working full time, and the large quantities of coal accumulated for some time past are now being reduced. Disturbances have lately taken place at various collieries in South and West Durham; and at those of Messrs. Joicey, there has been a strike for an advance of wages.

A seventh share in the Seaton Delavel Colliery was offered for sale on Sept. 29th, but was not purchased. The operations of the Wellington Colliery at Newhaven have been entirely stopped on account of the fire which broke out in it, and which has not yet been put out.

The iron trade has been very brisk all through the month, especially in Cleveland, where it is said the makers have orders in hand amounting to upwards of 200,000 tons, which will take the entire produce of that district for the next three months. Large quantities of hematite ore have also to worked in Cumberland on account of the increased demand for it.

It is reported that new works for making steel are to be built at Tow Law, by Mr. Charles Atwood, also forty new puddling furnaces at Jarrow, by Messrs. Palmer Brothers and Co. Messrs. Head and Co., of London, have purchased land at Newport for the purpose of erecting some rolling mills.

We gave last month an account of the number of furnaces in and out of blast in Cleveland and South Durham, showing that altogether there were eighty furnaces in existence in that district, of which sixty-three were in blast. To these may be added the following statistics of other furnaces in the county of Durham, namely:—

| Place and Owners. | In. | Out. | Total. |
|---|---|---|---|
| Seaham—Marchioness of Londonderry .. .. | 2 | — | 2 |
| Hinderwell—Albert Works.. .. .. .. | 1 | — | 1 |
| Ferryhill—James Morrison.. .. .. .. | 3 | — | 3 |
| Washington—Bells, Hawks, and Co. .. .. | 1 | — | 1 |
| Jarrow—Palmer Brothers .. .. .. .. | 3 | 1 | 4 |
| Birtley—Birtley Iron Company .. .. .. | 2 | 1 | 3 |
| Telling—H. L. Pattinson and Co. .. .. .. | — | 2 | 2 |
| Total .. .. .. .. | 12 | 4 | 16 |

making a total of seventy-five furnaces in blast, and twenty-one out of blast, in the northern district south of the Tyne.

The exports from the Tyne include:—211,125 tons of coal; 12,919 tons of coke; and 95,027 cwts. of iron. The imports during the month have been:—19,662 bars of lead from Carthagena, 1,350 from Seville, 2,700 from Alicante, 2,705 from Garrucha, and 9,050 from Rotterdam; cargoes of manganese from Huelva and Rotterdam; cargoes of sulphur ore from Pomaron, Cadiz, and Gefle; cargoes of pyrites from Dordt and Antwerp; and bar-iron from Rotterdam and Gothenberg.

YORKSHIRE AND LANCASHIRE.—The coal trade continues very active, and the demand for the London Market good; prices have been firmly maintained, and a ready sale has been effected.

The iron trade has improved, and the general opinion is that it will continue to do so throughout the winter. The workmen employed by the Kirkless Hall Company near Wigan have struck, in consequence of their employers proposing to reduce their wages.

## SCOTLAND.

There has been a good demand for coal during the month, and prices have been fully maintained with an upward tendency.

The iron market has experienced a rise during the month, an extensive business has been transacted, and manufacturers have been unusually busy. Bar-iron has been firm at advanced prices, and the makers have been well supplied with orders. The pig-iron market has also had an upward tendency, and an extensive business has been done. A rise of 2*s.* 6*d.* per ton was established at the beginning of the month; makers of all kinds have been fully employed, whilst many have sufficient orders to last till December. A scarcity of hands has been felt, as in England, and is becoming quite a source of annoyance, as some of the makers are scarcely able to keep their works in full operation. A meeting was held on the 15th at Glasgow, at which the coal and ironmasters agreed to advance the miners' wages at the rate of 6*d.* per day, and it is hoped that this will put an end to the strike which has taken place in some parts of the west of Scotland, and prevent any further dissatisfaction amongst the operatives.

The shipments during September amounted to 56,153 tons against 49,079 tons during the corresponding month of last year, showing an *increase* of 7,084 tons. The shipments for the three quarters also show a large increase over those of the corresponding quarters of 1860 and 1861; they were as follows:—

| | 1863. | 1862. | 1861. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| First quarter.. .. .. .. | 120,243 | 128,838 | 103,811 |
| Second quarter .. .. .. | 178,971 | 165,788 | 201,859 |
| Third quarter .. .. .. | 166,868 | 147,685 | 142,280 |
| Total .. .. .. | 466,082 | 442,311 | 447,980 |

## FOREIGN AND COLONIAL.

FRANCE.—The St. Dizier iron trade has shown less firmness of late, and little business has been transacted during the month. The rise in the price of iron in England has had more effect upon the Havre market than elsewhere. Supplies of wood have been laid in at a reduction from last year's quotations, the general price being 10*s.* 2*d.* per five cubic metres.

BELGIUM.—The coal trade is promising, numerous orders have been received, especially from Paris, and as this will greatly reduce the stock, it has been agreed to maintain the prices decided upon some time ago. The iron trade is also upon the whole prosperous, and some advance in prices has been made at Liége. The Belgian ironmasters have held a meeting at Brussels, which has induced greater firmness and confidence in prices. In the Charleroi market refinery pig was quoted at 3*l*. 4*s*., and the masters have declined entering into any engagements for long periods.

Messrs. Dorlodot Brothers have received orders for rails for the state line, and the Charleroi, Thy-le-Chateau, Couillet and Chatelineau works have also entered into contracts for a large quantity of rails. It is reported that a proposal has been made to turn to account a bed of bituminous schist existing in the Gilly Collieries, and which has hitherto only been used in experiments for the production of gas.

PRUSSIA.—The *Deep Dale Mining Company*, limited, with a capital of 20,000*l*., in shares of 2*l*. each, propose working some mining property at Fell, near Trier, in Rhenish Prussia.

SARDINIA.—It is said that the *Sardinian Mining Company* has issued a prospectus. The capital is 100,000*l*., in shares of 10*l*. each. The property proposed to be worked is about 40,000 acres in extent, and is situated near Iglesias, thirty miles from Cagliari.

NOVA SCOTIA.—Mining in this province is progressing with considerable activity. Besides two English companies there are several American companies from New York and Boston working at the gold-fields on a large scale, the largest of which are under the direction of Mr. M. D. Field, of Massachusetts. The coal mines of the Association at Pictou, Joggins, and Cape Breton are in a most flourishing condition under the able management of Mr. Scott; and several other collieries are working on a small scale in their neighbourhood, particularly in Cape Breton Island.—The works of the Acadian Iron Mines, Londonderry (which are principally owned in Sheffield), are also in a sound condition under the practical management of Mr. E. A. Jones. There is one furnace in blast, working about forty weeks in the year, the other twelve weeks being consumed in the half-yearly repairs, which each occupy about six weeks. The make is about 50 tons a week, or 2,000 tons a year—about 1,200 tons of which are rolled into bars for steel-making, and 800 tons exported as pig. The value of the former in Liverpool is from 16*l*. to 17*l*. per ton, and of the latter from 7*l*. to 8*l*.; the loss on rolling being only 5 °/₀. To make this 2,000 tons of iron about 4,000 tons of ore are raised, which cost $4 (16*s*.) per ton delivered at the furnace. The ore (which is principally a rich hematite) is smelted by charcoal, and the iron is puddled by wood fuel: the latter operation consumes about 2½ cords of wood at $2 per cord, which consequently costs about $5 (1*l*.). The blast is slightly heated (to 150° Fahr.), and the pressure is only ½ lb. The ore is at present being raised at a distance of two or three miles from the furnace, and a considerable supply is already laid open; but an adit level is now driving, and is near the vein, 10 fms. below the present workings; and another, 15 fms. again deeper, has also just been commenced. We shall probably refer to the mining operations of this province more fully on an early occasion.

AUSTRALIA.—The following advices have been received by the Australian mail from the different mining companies.—At *Kapunda* the quantity of ore raised in June was 277 tons of 18½ °/₀ average produce, equal to 51½ tons of pure copper, exclusive of 170 tons of sulphur ore for flux. The quantity raised in July is estimated at about 330 tons of good quality. All was going on satisfactorily in sinking the Buhl engine-shaft to the 70 fathom, and considerable activity is reported in all the pitches and other works. The 51 tons of copper made in July had been shipped to London; and of the quantity made in August 41 tons had been forwarded

to Melbourne for transshipment, leaving 15 tons in store. The smelting works were in full operation, all furnaces a-light, and fuel still coming in freely.

From *English and Australian* the directors have advices from Port Adelaide up to Aug. 27th. The quantity of coal at Kapunda was 734 tons; at Port Adelaide, 1,990½ tons; and at Kooringa, 170 tons, besides about 1,700 tons of wood. At the works there were five furnaces and one refinery at work. Since the date of the last advices 110 tons of copper had been shipped.

From *Great Northern* they report that the branch of ore referred to in the last advices has not proved to be of any importance.

From *Yudanamutana* they advise that on the whole the mine looks better than it did last month. The building of the smelting works is progressing favourably. Since last report they have sent to port 40 tons of ore of 25 to 28°/ₒ. The yield during the past month has been—cartable ore, 50 tons, and ore for smelting, say 200 tons; alvans, and rock for crushing, 100 tons. The quantity of ore now ready for smelting on the mine is about 2,000 tons, say 15°/ₒ. The poorer ore requiring crushing and reducing is about 2,000 tons.

At *Worthing* the expenses for the month were 1,588*l*. Ore raised in the month, 260 tons of average produce; regulus returned, 52 tons of good quality; regulus delivered to the English and Australian Copper Company, 51 tons. They had commenced to stope in the back of the 43-fathom level, where they had a leader of solid ore 3′ to 5′ wide, at present yielding 8 to 10 tons of ore per fathom. They had recommenced sinking Lean's engine-shaft, and sinking about 4′ had come on a large lode 4 or 5′ wide. All the other parts of the mine were looking well.

From *Fortune* (Western Australia) the company have letters from Fremantle, dated the 24th of August, advising the arrival of the Hastings with the miners and machinery on the 26th of July, and that freight had been engaged by that vessel for the lead ore relanded ex African, about 230 tons, also enclosing bill of lading for 125 tons of copper ore shipped per Ismyr.

# Record of the Mining and Metal Markets.

## METALLIC-ORE MARKETS.

TIN.—The standards for black tin have been advanced 2*l*. and are now:—

| | | | |
|---|---|---|---|
| Superior Fine | .. £110 .... | Superior Common | .. £107 |
| Second Fine | .. 108 .... | Second Common | .. 105 |

The standard is, however, very unsettled, and it is reported that a reduction from present rates may be expected.

COPPER.—At the four Cornish sales we give this month, the number of tons, average produce, quantity of fine copper, average price per ton, and standard have been as follows:—

| *Date.* | *Tons.* | *Produce.* | *Fine Copper.* Tons. cwt. | *Price per ton.* | *Standard.* |
|---|---|---|---|---|---|
| Sept. 24. | 2,747 | 7⅜ | 201 1 | £5 10 6 | £113 1 0 |
| Oct. 1. | 3,202 | 6½ | 208 17 | 4 18 6 | 117 12 0 |
| „ 8. | 1,876 | 7¼ | 136 10 | 5 14 6 | 116 9 0 |
| „ 29. | 4,887 | 6⅛ | 297 10 | 4 18 6 | 125 4 0 |

The copper standard has rapidly and largely advanced all through the month. At the sale of the 24th, 1*l.* 15*s.*; at that of Oct. 1st, 1*l.*; at that of the 8th, 2*l.*; and again at that of the 22nd, 2*l.* 10*s.*, making altogether an advance of upwards of 7*l.*

LEAD.—Comparing this month's sales with those of last, we find that prices have slightly advanced.

## COAL MARKETS.

LONDON, *October* 29*th.*—From the returns of the Registrar of the London Coal Exchange, of the quantity of sea-borne coal, culm, and cinders, imported into London in the month of September, we learn that the total quantity was 274,187 tons, against 260,199 tons during the corresponding month of last year,—showing an *increase* of 13,988 tons.

The following are the particulars of the 274,187 tons imported during September:—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Newcastle .. | 91,770 tons, in | 232 ships | | Scotland .. | 3,705 tons, in | 17 ships |
| Seaham .. | 19,688 „ | 82 „ | | Wales .. | 7,659 „ | 18 „ |
| Sunderland. | 84,747 „ | 204 „ | | Yorkshire .. | 2,583 „ | 28 „ |
| Middlesbro'. | 6,509 „ | 21 „ | | Small .. | 1,332 „ | 2 „ |
| Hartlepool.. | 53,964 „ | 197 „ | | Cinders .. | 1,661 „ | 8 „ |
| Blyth .. | 569 „ | 2 „ | | | | |

The quantity of coal imported by railways and canals during the month of September was 168,385 tons, against 145,173 tons during the corresponding month last year—showing an *increase* of 23,212 tons.

In the London coal market a fair amount of business was transacted during the early part of the month, but towards the end the market was very quiet. On September 30th, the new ships arrived were 24; an advance of from 3*d.* to 6*d.* The prices were:—Hetton Wallsend, 20*s.*; Braddyll's Wallsend, 18*s.* 6*d.*; Lambton Wallsend, 18*s.* 6*d.*; Eden Main, 18*s.*; Butes Tanfield Moor, 14*s.*; Tees Wallsend, 17*s.* 3*d.*; Steward's Wallsend, 18*s.* 6*d.*; South Kelloe Wallsend, 18*s.*; Hasting's Hartley, 16*s.* 6*d.*; West Hartley, 17*s.* 6*d.* On October 2nd, new ships 100, market very active, with an advance of from 9*d.* to 1*s.* On the 5th, new ships 35, market brisk, with another advance of from 6*d.* to 9*d.* On the 7th, new ships 131, market busy. On the 9th, new ships 24; Hartley's advanced 3*d.* On the 12th no new arrivals of ships, market quiet. On the 14th, but 2 or 3 new ships; Hartley's again advanced 3*d.* On the 16th, the fresh arrivals were all steamers, and consequently there was no sale on the market. On the 19th, new ships 32, market firm. On the 21st, new ships 82, transactions limited; Hartley's reduced 3*d.* On the 23rd, new ships 181, business moderate; Hartley's fell 1*s.* On the 26th, new ships 81, market active. On the 28th, new ships 16, market steady. The prices were:—Haswell Wallsend, 20*s.*; Stewart's Wallsend, 19*s.* 6*d.*; Russell's Hetton Wallsend, 19*s.*; Braddyll's Wallsend, 19*s.*; Eden Main, 17*s.* 6*d.*; Davison's West Hartley, 15*s.* 6*d.*; West Hartley, 15*s.* 6*d.*; Tanfield Moor, 15*s.*; Butes Tanfield, 14*s.* 9*d.*

LIVERPOOL.—From Messrs. J. and T. Platt's Coal Circular for September, we find that the quantity of coal, cannel, coke, and patent fuel shipped from Liverpool to foreign and colonial ports during the month of September was 59,184 tons, against 63,895 tons during the corresponding month of last year—showing a *decrease* of 4,711 tons. The total shipments from January to September were 407,707 tons, against 472,475 tons in the corresponding period last year—showing a *decrease* of 64,768 tons. The ex-

ports coastwise during September were 13,328 tons, against 11,145 tons during the same month last year—showing an *increase* of 2,183 tons. The total exports coastwise from January to September were 74,092 tons, against 60,535 tons during the corresponding period of last year—showing an *increase* of 13,557 tons.

CONTRACT FOR COAL.—The Admiralty require the supply of 2,500 tons of South Wales coal, to be delivered into store at Sierra Leone.

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## SHARE MARKETS.

LONDON, *October 29th.*—There has been a fair amount of activity in the London share market during the past month, and prices have generally had a favourable tendency. At the end of the month, however, little business was transacted owing to the fortnightly settlement.

*East Caradon* shares have been dull all through the month, and have varied but little in price. They opened on the 29th at our last quotation of 28½*l*.-29*l*. On the 5th they were in demand, and rose to 30¼*l*.-30¾*l*., but on the 6th they began to decline, and continued to do so daily until the 14th, when they stood at 25¾*l*.-26¼*l*.; by the 23rd they had again risen to 27*l*.-27½*l*., and close at 26¾*l*.-27*l*. There has been very little change in *Marke Valley* shares, which opened at 6¼*l*.-6½*l*., and close at 6*l*.-6¼*l*. *Gonamena*, 2¾*l*.-3¼*l*. *West Caradon*, 21*l*.-22*l*. *South Caradon*, 415*l*.-425*l*. *Glasgow Caradon*, 4½*l*.-4¾*l*. *Caradon United*, 1¼*l*.-1¾*l*. *Caradon Vale*, 3*l*.-3½*l*. *New South Caradon*, 8*s*.-10*s*.

*West Chiverton* shares have considerably advanced during the month. They opened on the 29th at 46*l*.-48*l*. On the 30th they advanced to 47½*l*.-50*l*., but on the 5th fell to 47*l*.-48*l*. After this they gradually improved until the 17th, when they had reached 50*l*.-51*l*. On the 19th they rose 4*l*., but receded again being pressed for account, and close 51*l*.-53*l*. *Chiverton* shares have advanced from 8¾*l*.-9*l*. to 11*l*.-11½*l*. *East Chiverton* shares, which opened at 5*l*.-5½*l*., advanced at one time to 8¼*l*.-8¾*l*., but close at 7*l*.-7½*l*. *Wheal Ludcott and Wrey*, 2*l*.-2¼*l*. *Trelawny*, 20*l*.-21*l*. *Herodsfoot*, 35*l*.-36*l*. *Wheal Mary Ann*, 12*l*.-12½*l*. *Wheal Hope*, 5*l*.-5½*l*. *North Shepherds*, 2¾*l*.-3*l*. *Chiverton Moor*, 7½*l*.-8*l*.

*Wheal Margaret* shares have receded 6*l*. during the month. They opened on the 29th at 25*l*.-27*l*.; on the 30th they fell to 24*l*.-26*l*.; on the 13th to 23*l*.-25*l*., and again on the 17th to 19*l*.-21*l*., at which they close. *New Rosewarne* shares have risen rapidly during the month; they opened at 5½*l*.-5¾*l*., but by the 7th were quoted at 18*l*.-20*l*., and improved daily till the 20th, when they had reached 27*l*.-29*l*., but fell slightly during the next three days. They however improved again, and close at 28*l*.-29*l*. *Great Wheal Fortune*, 26*l*.-27*l*. *Sithney Carnmeal*, 5*l*.-5½*l*. *Providence*, 44*l*.-45*l*. *Basset and Grylls*, 20*l*.-22*l*. *Wheal Grylls*, 29*l*.-30*l*. *Calvadnack*, 6*l*.-6½*l*. *Wendron Consols*, 10*l*.-12*l*. *Great Wheal Vor*, 9½*l*.-10*l*. *Wheal Kitty* (Lelant), 14*l*.-15*l*. *Wheal Margery*, 6*l*.-7*l*. *East Grylls*, 8*l*.

*East Basset* shares opened on the 29th at 79*l*.-81*l*., being a reduction of 2*l*. from last month's closing prices, and have receded altogether 9*l*., closing at 70*l*.-72*l*. *Wheal Buller*, 25*l*.-30*l*. *North Basset*, 2¾*l*.-3¼*l*. *South Frances*, 65*l*.-70*l*. *Wheal Grenville*, 5¾*l*.-6*l*. *East Grenville*, 3⅛*l*.-3⅜*l*. *South Grenville*, 4*s*.-5*s*. *Wheal Basset*, 75*l*.-80*l*.

*Clifford Amalgamated* shares have considerably improved during the month. They opened at 33*l*.-34*l*., and after almost daily advancing, close at 39*l*.-40*l*. *Nanjiles* shares have also improved from their opening quotation of 24½*l*.-25½*l*. to 29*l*.-31*l*. *Grambler and St. Aubyn*, 12*l*.-14*l*. *North Grambler*, 4*l*.-4½*l*. *St. Day United*, 23*l*.-25*l*. *Great Wheal Busy*, 3¾*l*.-4*l*.

*Cook's Kitchen* shares have declined from 24*l*.-25*l*. to 21½*l*.-22½*l*. *Tincroft*, 19*l*.-19½*l*. *Stray Park*, 36*l*.-37*l*. *Wheal Crofty*, 3*l*.-3½*l*. *Wheal*

*Harriett*, 1¾l.-2l. *South Crofty*, 23l.-25l. *Camborne Vean*, 2½l.-3l. *West Stray Park*, 3l.-3½l.

*Wheal Seton* shares have gradually declined from 200l.-210l. to 180l.-185l. *North Crofty*, 6l.-6¼l. *West Seton*, 220l.-230l. *West Tolgus*, 53l.-55l. *Wheal Agar*, 3l.-3½l. *New Seton*, 105l.-110l.

Transactions have also been reported in the following mines:—*East Russell*, 3¼l.-3½l. *Drakewalls*, 36l.-38l. *Wheal Crebor*, 28l.-30l. *Devon Great Consols*, 545l.-550l. *Lady Bertha*, 10s.-12s. 6d. *North Robert*, 7s. 6d.-10s. *Kelly Bray*, 15s.-17s. 6d. *New Wheal Martha*, 1½l.-1¾l. *East Gunnis Lake and South Bedford*, 1l.-1¼l. *Wheal Edward*, 5s. 6d.-6s. 6d. *Bedford United*, 2¾l.-3¼l. *Gawton United*, 7s. 6d.-10s. *East Carn Brea*, 7l.-7¼l. *Wheal Union*, 2¾l.-3l. *Wheal Uny*, 5l.-5¼l. *South Tolgus*, 30l.-35l. *Great South Tolgus*, 4¾l.-5l. *North Downs*, 1⅜l.-1⅞l. *Carn Brea*, 66l.-68l. *North Treskerby*, 2⅞l.-3⅛l. *Wheal Unity*, 10s.-12s. 6d. *North Dolcoath*, 2l.-2½l. *Wheal Kitty* (St. Agnes), 7⅝l.-7⅞l. *East Rosewarne*, 2¼l.-2½l. *Pendeen Consols*, 6¾l.-7l. *Tolvadden*, 1⅞l.-2⅛l. *Tremayne*, 6½l.-7½l. *Treloweth*, 1l.-1¼l.

In Welsh mines prices have been quoted as follows:—*Bryn Gwiog* shares have advanced from 31l.-33l. to 33l.-34l. *Long Rake*, 4¼l.-4½l. *Billins*, 17l.-18l. *Cambrian Consols*, 10s.-12s. 6d. *Cwm Erfin*, 21l.-23l. *Pant-y-Pydew, North Minera*, 5s.-7s. 6d. *Merllyn*, 12s.

In Foreign and Colonial mines business has been transacted at the following rates:—*Yudanamutana*, 2¾l.-2⅞l. *East Del Rey*, 15s.-17s. 6d. *United Mexican*, 6¾l.-7l. *Cobre Copper*, 27½l.-28½l. *Copiapo*, 8¼l.-8½l. *Don Pedro North Del Rey*, 1l.-1⅛l. *St. John Del Rey*, 56½l.-57l. *Mariquita*, 10s.-12s. 6d. *Vallanzasca*, ⅞l.-1l. *Cape Copper*, 3⅝l.-4l. *Kapunda*, ⅞l.-1l. *Port Phillip*, 1⅛l.-1¼l. *Worthing*, 10s. *Fortuna*, 4l.-4¼l. *Alamillos*, 10s. *Linares*, 6½l.-7l. *Santa Barbara*, 10s. *Scottish Australian*, 12s. 6d.

CORNWALL.—The Cornish mining share market has been very active all through the month, and a large amount of business has been transacted. *New Rosewarne* has been the principal object of attraction, the shares in which have advanced upwards of 20l. per share, from 5½l.-5¾l. to 27½l.-28½l., or upwards of 20,000l. for the mine. *South Crofty* shares have been dull at 24l.-25l. *Sithney Carnmeal*, 5½l.-6l. *Great Fortune*, 27l.-28l. *Wheal Emily Henrietta*, 9l. *Cargoll*, 41l.-42l.

DUBLIN.—The Irish mine share market stands in much the same position as last month, and but little business has been transacted. *Wicklow Copper* shares have been well maintained, and have advanced 10s. They close at 13l. *General Mining Company of Ireland*, 4½l.-4⅝l. *Mining Company of Ireland* shares have slightly receded to 18⅝l. *Carysfort*, 19s. 6d. *Connorree*, 15s. *Crookhaven*, 15s. *Carbery*, 9s. 6d.

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## METAL MARKETS.

LONDON, *October 29th*.—The metal market has been very steady all through the month, and a good deal of business has been done.

IRON.—The iron trade has been very firm, and in some instances an advance in prices has been established.

An extensive business has been done in Scotch pig-iron, and prices have advanced from 59s. 6d. to 60s. 7½d. cash, and from 60s. to 61s. 6d., three months prompt.

There has been a very good demand for Welsh bars at 7l. f.o.b., and makers have been well supplied with orders. Staffordshire descriptions have been very firm at the advanced rates.

STEEL.—Few transactions have taken place, and prices remain unaltered.

COPPER.—A large amount of business has been transacted in this metal, and on the 12th the smelters officially advanced the price of raw manufac-

tured 3*l*. per ton, making present quotations:—Sheet and sheathing, 105*l*.; best selected, 101*l*.; cake, tile, and ingot, 98*l*. Business in foreign has been restricted for want of stock. Burra Burra, 100*l*. Kapunda, 102*l*. Spanish, 93*l*. Chili, 90*l*.

YELLOW METAL.—This article has also advanced to 9¼*d*. per lb., and has been in good demand for export.

TIN.—There has been little business doing in this metal, and English has been obtainable at 2*l*. to 3*l*. under fixed prices. Foreign has been difficult of sale, and large arrivals were reported during the latter part of the month. Straits, 115*l*. 10*s*. to 117*l*. cash. Banca, nominally, 120*l*. The Dutch market has been flat at 71 fl.

TIN PLATES.—This article has been in fair demand, and prices show an upward tendency.

LEAD.—Very little business was reported in this metal until towards the end of the month when there was more demand, and prices advanced 7*s*. 6*d*. per ton. Good soft English, 20*l*. 5*s*. to 20*l*. 7*s*. 6*d*.

SPELTER.—The activity shown in this article last month has entirely subsided, and very little business has been transacted in it during the past month. Prices have consequently declined and may now be quoted at 18*l*. 5*s*. on the spot; 18*l*. 7*s*. 6*d*. to 18*l*. 10*s*. for forward delivery.

LIVERPOOL, *October* 28*th*. IRON.—The market for Scotch pig-iron opened very active at 61*s*. cash, 62*s*. three months' open. Prices continued advancing until the 6th, when a considerable business was done at 64*s*. Since then the market has been quieter, but a fair amount of transactions has been reported at prices varying from 60*s*. 6*d*. to 62*s*. 9*d*., the closing quotation being 61*s*. cash, 62*s*. 6*d*. three months' open.

GLASGOW, *October* 28*th*. IRON.—During the early part of the month very large transactions were reported in Scotch pig-iron, but towards the close the market became quieter, although a considerable amount of business was done. Prices opened on the 27th at 59*s*. 3*d*. cash, 60*s*. three months. On Oct. 1st the tone of the market was very firm, and a large business was done at 60*s*. 9*d*. to 61*s*. 6*d*. cash. On the 6th prices had advanced to 63*s*. 3*d*., but declined on the 7th to 62*s*. 3*d*., and after then steadily receded until the 14th, when they were 60*s*. The market remained steady at this until the 21st when prices advanced to 61*s*. 3*d*. Since that date the tone of the market has been quiet, but a fair amount of business has been transacted at prices varying between 60*s*. 6*d*. and our closing quotation of 61*s*. 9*d*.

PARIS, *October* 26*th*. COPPER.—This metal has advanced in price, and has been in fair demand. English, 237½ fr. Chili, 225 fr.

TIN.—The market for this metal has been very quiet, and few transactions are reported. Banca, 322½ fr. Straits, 310 fr.

COLOGNE, *October* 19*th*.—There has been a fair amount of business transacted during the past month, especially in copper and iron, which have advanced in price in sympathy with the English market. Tin and spelter remain without change; lead has slightly advanced.

AMSTERDAM, *October* 17*th*. COPPER.—The market for this metal has been active, and prices have advanced to 52½-53½ fl.

TIN.—In Banca nothing has been doing, and it is now quoted at 72 fl.

BRESLAU, *October* 17*th*. SPELTER.—This article has been dealt in at 5 thalers 10½ sgr.

HAMBURG, *October* 15*th*. The metal market has been fairly active, and prices have had an upward tendency.

IRON.—Scotch pig-iron, 2¾ mk. English in bars, 5¾ mk. Staffordshire descriptions, 6¾ mk.

COPPER.—The price of English has been advanced 3*l*., and the market

has been very firm. English, best selected, 68 mk. Demidoff, 69½ mk. Burra Burra and Kapunda, 67 mk.

TIN.—The market for this metal has been very fluctuating, but on the whole prices have been lower.

SPELTER.—This article has been in good demand at 16¼ mk.

STETTIN, *October* 17*th*. COPPER.—English, 33 to 35 thalers.

TIN.—Banca, 44 to 45 thalers.

BERLIN, *October* 17*th*. There have been few changes of importance in the metal market during the past month.

IRON.—A good deal of business has been done in Scotch pig-iron at 49 to 51 sgr. Iron in bars, 3¾ to 4 thalers. Staffordshire descriptions, 5¼ thalers.

COPPER.—There has been an active market for this metal at rather advanced prices. Paschkoff, 43 thalers. Demidoff, 36 thalers. Mansfeld refined, 34 thalers. English, 33 to 33½ thalers.

TIN.—This metal remains quiet at unaltered prices. English, 40 thalers. Banca, 43 thalers.

LEAD has been in demand at from 6¾ to 7 thalers.

SPELTER.—This article has been quiet at 5 thalers 18 sgr. for W. H.; ordinary brands, 5 thalers 15 sgr.

HONGKONG, *September* 11*th*. LEAD.—Sales reported 7,583 piculs; common, \$6·60 to \$6·90; W.B. mark, \$6·80 to \$7·20.

IRON shows little alteration. Sales 2,170 piculs.

AMOY, *September* 3*rd*. LEAD.—Sales 461 pigs, at \$7·40 per picul.

FOOCHOW, *September* 1*st*. LEAD.—Sales 800 piculs, at \$8·50.

SHANGHAI, *September* 3*rd*. LEAD.—Sales 5 to 6 taels.

IRON.—Sales 2 to 3 taels.

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*Furnished by Von Dadelszen and North*, 158, *Leadenhall Street, London, E.C.*

At the beginning of the month there were unmistakeable signs of activity in the metal markets generally, which have been fully borne out by the large business that has been done; buyers operate freely, and there is every prospect of prices being firmly maintained, and in some articles much confidence is felt that a further considerable rise in value will take place.

IRON.—This article is very firm, and makers are unwilling to enter orders excepting at full rates. Not only has the official rise of 30*s*. per ton announced in our last as having taken place in both Welsh and Staffordshire been confirmed, but the demand has been so very active at it, that there exists a strong feeling in certain well-informed quarters that a further official advance in Staffordshire descriptions is imminent. We quote Welsh bars 7*l*. per ton f.o.b. in Wales, and 7*l*. 10*s*. here. In Scotch pigs a very extensive business has been done based upon the increased shipments and consumption, as well as on the diminution in the stocks; the price has varied from 61*s*. to 63*s*. 3*d*. three months, and closes 62*s*. 9*d*. same term.

COPPER.—The smelters are full of orders, and, although quiet, prices are firm for English raw and manufactured, and few second-hand parcels are to be had. Business in foreign is restricted. We quote Burra 100*l*.; Kapunda, 102*l*.; Chili, 90*l*.

TIN.—This metal has been very flat. English to be had 2*l*. 15*s*. to 3*l*. under official rates. Straits, 115*l*. 10*s*. cash, 117*l*. three months' prompt. Banca offered here at 120*l*.; in Holland, 71fl. sellers.

TIN PLATES.—Charcoals obtain full rates, and a steady business is being done in cokes, at prices rather in sellers' favour.

LEAD.—An advance of 10*s*. per ton has taken place.

SPELTER.—Very little business has been done, and the article has continued its downward tendency; a fall of about 10*s*. per ton has taken place; closing sellers 18*l*. 5*s*.; spot 18*l*. 7*s*. 6*d*.; forward Hull parcels, 18*l*. 2*s*. 6*d*.

# PRICES CURRENT OF METALS.

From Messrs. James and Shakspeare's, 10, Austin Friars, E.C., 29th *Oct.*

| | | | | |
|---|---|---|---|---|
| | | Per Ton. | | |
| IRON | Bars (Welch) .. in Wales .. | £6 15 0 | @ | £7 0 0 |
| | " " .. " Liverpool | —— | " | 7 5 0 |
| | " " .. " London | 7 10 0 | " | 7 15 0 |
| | Nail Rods " .. " Wales | 7 5 0 | " | 7 10 0 |
| | " (Staffordshire) " Liverpool | 8 5 0 | " | 9 2 6 |
| | " " " London | 8 15 0 | " | 9 10 0 |
| | Hoops " " Liverpool | 9 10 0 | " | 10 2 6 |
| | " " " London | 10 0 0 | " | 10 10 0 |
| | Sheets " " Liverpool | 10 10 0 | " | 11 2 6 |
| | " " " London | 11 0 0 | " | 11 10 0 |
| | Bars " " Liverpool | 8 10 0 | " | 9 2 6 |
| | " " " London | 9 0 0 | " | 9 10 0 |
| | Scotch Pig (No. 1. g.m.b.) the Clyde | 3 1 0 | " | 3 1 6 |
| | Rails ................ in Wales | —— | " | 6 15 0 |
| | Swedish—Hammered—large sizes | —— | " | 11 15 0 |
| | " " Indian assortments | 12 10 0 | " | 13 10 0 |
| STEEL | " " Hammered—faggot | 17 0 0 | " | 17 10 0 |
| | " " in kegs (¼ and ⅛ in.) | —— | " | 16 0 0 |
| COPPER Australian | Burra and P.C.C. | —— | " | 100 0 0 |
| | Kapunda | 103 0 0 | " | 103 10 0 |
| | Wallaroo | —— | " | 100 0 0 |
| American | Baltimore | —— | " | none |
| | Lake Superior | —— | " | " |
| | Spanish Cake | —— | " | 94 0 0 |
| | Chili and other Slab (for 96 per cent. pure Copper) | 89 0 0 | " | 90 0 0 |
| English | Tough Cake and Ingot and Tile | —— | " | 98 0 0 |
| | Best selected Ingot | —— | " | 101 0 0 |
| | Sheets, Sheathing and Rod | —— | " | 105 0 0 |
| | Flat Bottoms | —— | " | 110 0 0 |
| | | Per lb. | | |
| YELLOW METAL | Sheets | 8½*d.* | @ | 9*d.* |
| | Sheathing and Rod | 9*d.* | " | 9½*d.* |
| | | Per Cwt. | | |
| TIN English | Common Blocks and Ingots | 113*s.* | @ | 115*s.* |
| | " Bars (in barrels) | 114*s.* | " | 116*s.* |
| | Refined | —— | " | 120*s.* |
| Foreign | Straits, Fine | 116*s.* | " | 117*s.* |
| | " (with 3 months' prompt) | 117*s.* 6*d.* | " | 118*s.* |
| | Banca | —— | " | 122*s.* |
| | | Per Box. | | |
| TIN PLATES at Liverpool 6*d.* Less | Charcoal IC, best | 29*s.* 0*d.* | @ | 30*s.* 0*d.* |
| | " IX " | 35*s.* 0*d.* | " | 36*s.* 6*d.* |
| | Coke IC | 23*s.* 6*d.* | " | 25*s.* 6*d.* |
| | " IX | 29*s.* 6*d.* | " | 31*s.* 6*d.* |
| | | Per Ton. | | |
| LEAD English | Sheet | —— | @ | £20 15 0 |
| | Pig—W.B. | —— | " | 21 10 0 |
| | " Other good brands | £20 5 0 | " | 20 10 0 |
| | " German and Spanish, soft | 19 10 0 | " | 19 15 0 |
| English | Red | —— | " | 21 5 0 |
| | Shot | —— | " | 23 0 0 |
| | Dry White | —— | " | 26 0 0 |
| SPELTER | (Silesian) in Cakes | 18 0 0 | " | 18 5 0 |
| ZINC | (Sheet) No. 9 and upwards | —— | " | 24 0 0 |
| | | Per Bottle. | | |
| QUICKSILVER | (in bottles containing 75lbs. each) | —— | @ | 7 0 0 |
| | | Per Ton. | | |
| REGULUS OF ANTIMONY | French Star | —— | @ | 38 10 0 |

# Tabular Abstract of Mining Accounts for the Month.

| Date of Account. | Name of Mine, and Number of Shares. | Balances. Debit. | Balances. Credit. | Calls. Per Share. | Calls. Total. | Dividends. Per Share. | Dividends. Total. |
|---|---|---|---|---|---|---|---|
| | | £ s. d. | £ s. d. | £ s. d | £ s. d. | £ s. d. | £ s. d. |
| | CORNISH & DEVON MINES. | | | | | | |
| Sept. 15 | Carnyorth (2,048) | 608 4 3 | — | — | — | — | — |
| ,, 16 | Lanivet (3,000) | — | — | 0 15 0 | 2,250 0 0 | — | — |
| ,, 17 | West Condurrow (1,218) | 704 14 3 | — | 0 11 7 | 705 8 6 | — | — |
| ,, 18 | North Grambler (1,366) | — | — | 0 10 0 | 683 0 0 | — | — |
| ,, 21 | Wheal Harriett (5,120) | — | 2,036 0 0 | — | — | — | — |
| ,, 21 | Rosewarne United (3,848) | — | 370 11 8 | — | — | — | — |
| ,, 21 | Spearne Moor (280) | 271 4 2 | — | — | — | — | — |
| ,, 21 | Wheal Emily Henrietta (4,096) | 179 12 10 | — | 0 10 0 | 2,048 0 0 | — | — |
| ,, 22 | East Providence (3,896) | — | 78 0 0 | — | — | — | — |
| ,, 22 | South Tolgus (512) | — | 2,141 0 0 | — | — | — | — |
| ,, 23 | Wheal Reeth (240) | 239 10 9 | — | — | — | — | — |
| ,, 24 | Wheale Hearle (4,096) | — | — | 2 0 0 | 8,192 0 0 | — | — |
| ,, 25 | Devon Great Consols (1,024) | — | 33,155 5 0 | — | — | 9 0 0 | 9,216 0 |
| ,, 25 | Furze Hill Wood (6,000) | 571 1 8 | — | 0 2 0 | 600 0 0 | — | — |
| ,, 25 | Creegbrawse (512) | — | — | 1 0 0 | 512 0 0 | — | — |
| ,, 25 | Gurlyn (4,910) | 157 4 6 | — | — | — | — | — |
| ,, 26 | East Chiverton (2,000) | 355 5 2 | — | 0 10 0 | 1,000 0 0 | — | — |
| ,, 28 | East Rosewarne (5,000) | — | 263 15 2 | — | — | — | — |
| ,, 29 | South Caradon (512) | — | 5,096 7 7 | — | — | 5 10 0 | 2,816 0 0 |
| ,, 29 | Great Retallack (6,000) | 177 10 11 | — | 0 2 0 | 600 0 0 | — | — |
| ,, 29 | Gonamena (6,144) | 171 17 0 | — | 0 2 6 | 768 0 0 | — | — |
| ,, 29 | East Basset (512) | — | 1,015 0 0 | — | — | — | — |
| ,, 30 | Craddock Moor (1,055) | — | 957 7 7 | — | — | — | — |
| Oct. 2 | Devon and Cornwal United (4,076) | 1,531 10 1 | — | — | — | — | — |
| ,, 2 | East Wheal Falmouth (2,048) | 256 11 3 | — | 0 5 0 | 512 0 0 | — | — |
| ,, 5 | Tamar (9,600) | 108 0 0 | — | — | — | — | — |
| ,, 6 | Polhigey Moor (6,000) | 760 15 4 | — | 0 4 0 | 1,200 0 0 | — | — |
| ,, 6 | Wheal Basset (512) | — | 1,976 0 0 | — | — | 1 0 0 | 512 0 0 |
| ,, 6 | Wheal Kitty (Lelant) (1,024) | — | — | — | — | 0 10 0 | 512 0 0 |
| ,, 6 | Basset and Grylls (1,000) | — | — | — | — | 0 10 0 | 500 0 0 |
| ,, 6 | North Treskerby (5,936) | — | 1,333 13 4 | — | — | 0 3 0 | 890 0 0 |
| ,, 6 | Tolvadden (6,000) | — | 1,407 3 2 | — | — | — | — |
| ,, 6 | Garlidna United (1,024) | 774 4 4 | — | 0 15 0 | 768 0 0 | — | — |
| ,, 6 | Herodsfoot (1,024) | — | 2,217 9 2 | — | — | 1 15 0 | 1,792 0 0 |
| ,, 7 | East Caradon (6,144) | — | 6,054 17 10 | — | — | 0 16 0 | 4,915 4 0 |
| ,, 7 | Bedford United (4,000) | — | 218 11 3 | — | — | 0 1 0 | 200 0 0 |
| ,, 7 | Marke Valley (9,000) | — | 1,294 16 0 | — | — | 0 1 0 | 450 0 0 |
| ,, 7 | Carn Camborne (6,000) | 214 1 2 | — | 0 3 6 | 1,050 0 0 | — | — |
| ,, 7 | West Rose Down (1,000) | — | 148 8 10 | 1 5 0 | 1,250 0 0 | — | — |
| ,, 8 | Chiverton Wheal Rose (3,000) | — | 415 0 0 | — | — | — | — |
| ,, 8 | Wheal Norris (6,000) | 1,336 6 0 | — | 0 4 0 | 1,200 0 0 | — | — |
| ,, 8 | Nanjiles (1,024) | — | — | 1 0 0 | 1,024 0 0 | — | — |
| ,, 12 | Dolcoath (358) | — | 3,559 1 7 | — | — | 8 0 0 | 2,864 0 0 |
| ,, 12 | South Condurrow (6,138) | 346 7 9 | — | 0 2 0 | 613 16 0 | — | — |
| ,, 12 | Wheal Seton (396) | — | 1,953 0 0 | — | — | 3 0 0 | 1,188 0 |
| ,, 13 | West Seton (400) | — | 2,937 14 8 | — | — | 5 0 0 | 2,000 0 0 |
| ,, 13 | New Prospidnick (6,000) | 589 9 11 | — | 0 1 6 | 450 0 0 | — | — |
| ,, 14 | West Stray Park (1,056) | 181 16 0 | — | 0 10 0 | 528 0 0 | — | — |
| ,, 14 | Wheal Rose (2,000) | 1,504 18 10 | — | 1 0 0 | 2,000 0 0 | — | — |
| ,, 15 | Trumpet United (4,000) | 473 1 11 | — | 0 2 6 | 500 0 0 | — | — |
| ,, 16 | East Gunnis Lake and South Bedford Consols (4,000) | — | 266 7 8 | 0 5 0 | 1,000 0 0 | — | — |
| ,, 17 | Wheal Vyvyan (1,024) | 385 4 10 | — | 0 10 0 | 512 0 0 | — | — |
| ,, 19 | South Crofty (937) | 767 18 1 | — | 0 15 0 | 702 15 0 | — | — |
| ,, 19 | Gawton (4,000) | 738 1 1 | — | 0 5 0 | 1,000 0 0 | — | — |
| ,, 20 | South Carn Brea (6,000) | 3,001 5 11 | — | 0 10 0 | 3,000 0 0 | — | — |
| ,, 20 | Chiverton Moor (3,000) | — | — | 3 0 0 | 9,000 0 0 | — | — |
| ,, 20 | Wheal Union (6,000) | 346 0 0 | — | 0 2 6 | 750 0 0 | — | — |
| ,, 21 | Clifford Amalgamated (2,900) | — | 2,585 18 4 | — | — | 0 12 6 | 1,812 10 0 |
| ,, 21 | North Great Work (6,000) | — | 343 0 0 | — | — | — | — |
| ,, 22 | West Chiverton (3,000) | — | 4,842 18 9 | — | — | 0 15 0 | 2,250 0 0 |
| ,, 22 | Camborne Vean (4,600) | — | — | 0 4 0 | 920 0 0 | — | — |
| | WELSH & OTHER MINES. | | | | | | |
| Sept. 18 | Foxdale (2,800) | — | — | — | — | 1 0 0 | 2,800 0 0 |
| ,, 22 | Aberdovey (700) | 392 4 8 | — | 0 10 0 | 350 0 0 | — | — |
| ,, 24 | Cwmbrane (1,800) | — | 692 0 0 | — | — | — | — |
| ,, 26 | Cwm Erfin (867) | — | — | — | — | 0 15 0 | 650 5 0 |
| ,, 28 | Llangynog United ( ) | 761 1 3 | — | — | — | — | — |
| ,, 29 | Dolfrwynog (10,880) | — | 1,055 16 9 | — | — | — | — |
| ,, 29 | Dale Mine (30,000) | — | 247 5 9 | — | — | — | — |
| Oct. 9 | Vale of Towy (20,000) | — | 234 16 1 | — | — | — | — |
| ,, 21 | Garreg (1,000) | 243 7 11 | — | 0 2 6 | 125 0 0 | — | — |
| ,, 21 | Merllyn (4,480) | 245 11 4 | — | 0 1 0 | 224 0 0 | — | — |
| | FOREIGN MINES. | | | | | | |
| Sept. 24 | Linares (15,000) | — | 3,498 0 0 | — | — | — | — |
| Oct. 22 | Fortuna (25,000) | — | 3,333 0 0 | — | — | — | — |

# Copper Ores.

Sampled Sept. 9, and sold at the Royal Hotel, Truro, Sept. 24.

| Mines. | Tons. | Purchasers. | Price. £ | s. | d. |
|---|---|---|---|---|---|
| South Caradon ......... | 96 | 7 | £6 | 2 | 6 |
| | 90 | 2, 6 | 7 | 11 | 0 |
| | 67 | 1, 6 | 7 | 18 | 6 |
| | 52 | 1, 5, 6 | 17 | 14 | 0 |
| | 50 | 1, 5, 6 | 15 | 16 | 6 |
| | 49 | 1, 9 | 5 | 15 | 6 |
| | 38 | 6 | 8 | 18 | 6 |
| | 20 | 1, 3 | 6 | 5 | 6 |
| Great Wheal Busy ... | 85 | 7 | 2 | 16 | 0 |
| | 70 | 7 | 2 | 18 | 0 |
| | 64 | 8 | 1 | 18 | 0 |
| | 60 | 1, 5 | 1 | 18 | 6 |
| | 53 | 7 | 2 | 13 | 0 |
| | 38 | 7 | 3 | 2 | 6 |
| | 37 | 9 | 2 | 13 | 0 |
| | 21 | 3 | 6 | 3 | 0 |
| | 2 | 1, 5 | 42 | 0 | 0 |
| West Caradon ......... | 74 | 9 | 4 | 12 | 0 |
| | 69 | 1, 6 | 7 | 5 | 6 |
| | 67 | 1, 2, 6 | 7 | 13 | 6 |
| | 56 | 1 | 4 | 16 | 6 |
| | 50 | 6 | 8 | 1 | 0 |
| | 34 | 2 | 6 | 10 | 0 |
| | 30 | 10 | 3 | 19 | 6 |
| | 22 | 12 | 1 | 2 | 6 |
| North Treskerby ...... | 58 | 3 | 4 | 10 | 6 |
| | 57 | 3 | 3 | 13 | 0 |
| | 56 | 3 | 5 | 3 | 6 |
| | 55 | 3, 7 | 4 | 3 | 6 |
| North Treskerby ...... | 54 | 7 | £3 | 8 | 0 |
| | 52 | 9 | 4 | 15 | 0 |
| | 51 | 7, 9 | 4 | 2 | 6 |
| Clifford Amalgamated | 94 | 6 | 4 | 17 | 0 |
| | 78 | 5 | 3 | 14 | 6 |
| | 72 | 5 | 3 | 10 | 0 |
| | 28 | 5 | 2 | 18 | 6 |
| | 27 | 5 | 1 | 13 | 6 |
| | 26 | 5 | 2 | 14 | 6 |
| | 20 | 1 | 15 | 3 | 6 |
| | 14 | 1 | 4 | 3 | 6 |
| North Downs ......... | 45 | 6 | 5 | 3 | 6 |
| | 44 | 3 | 5 | 8 | 6 |
| | 43 | 3 | 5 | 8 | 0 |
| | 38 | 3 | 7 | 0 | 6 |
| Wheal Rose ............ | 60 | 1, 6 | 7 | 14 | 0 |
| | 53 | 7 | 5 | 5 | 6 |
| | 52 | 7 | 4 | 4 | 0 |
| Craddock Moor......... | 64 | 10 | 5 | 17 | 6 |
| | 62 | 3 | 5 | 11 | 6 |
| | 7 | 9 | 8 | 4 | 0 |
| Wheal Polmear ...... | 62 | 5 | 6 | 19 | 0 |
| | 30 | 5 | 5 | 17 | 0 |
| | 20 | 1, 6 | 13 | 7 | 6 |
| St. Day United......... | 38 | 2 | 3 | 19 | 6 |
| | 32 | 3, 5, 10 | 1 | 12 | 6 |
| Boscawen ............... | 35 | 6 | 5 | 7 | 0 |
| South Crinnis ......... | 18 | 5, 6 | 4 | 7 | 0 |
| Burra Burra ............ | 8 | 12 | 3 | 4 | 6 |

TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. £ | s. | d. |
|---|---|---|---|---|
| South Caradon ............... | 462 | £4,257 | 15 | 0 |
| Great Wheal Busy ......... | 430 | 1,261 | 15 | 0 |
| West Caradon ............... | 402 | 2,394 | 6 | 0 |
| North Treskerby ............ | 383 | 1,630 | 18 | 0 |
| Clifford Amalgamated ... | 359 | 1,558 | 7 | 6 |
| North Downs ............... | 170 | 970 | 14 | 6 |
| Wheal Rose .................. | 165 | 959 | 19 | 6 |
| Craddock Moor ............ | 133 | £779 | 1 | 0 |
| Wheal Polmear ............ | 112 | 873 | 18 | 0 |
| St. Day United............... | 70 | 203 | 1 | 0 |
| Boscawen ..................... | 35 | 187 | 5 | 0 |
| South Crinnis ............... | 18 | 78 | 6 | 0 |
| Burra Burra .................. | 8 | 25 | 16 | 0 |

EACH COMPANY'S PURCHASE.

| | Tons. | Amount. £ | s. | d. |
|---|---|---|---|---|
| 1 Vivian and Sons ......... | 319 | £2,559 | 6 | 5 |
| 2 Freeman and Co.......... | 139 | 883 | 4 | 2 |
| 3 Grenfell and Sons ...... | 427 | 2,167 | 16 | 11 |
| 4 Crown Copper Co. ...... | — | — | | |
| 5 Sims, Willyams & Co. | 407 | 2,073 | 14 | 2 |
| 6 Williams, Foster & Co. | 480 | 3,619 | 15 | 2 |
| 7 Mason and Elkington... | 554 | 2,203 | 0 | 6 |
| 8 F. Bankart ............... | 64 | 121 | 12 | 0 |
| 9 Copper Miners' Co. ...... | 220 | £989 | 10 | 6 |
| 10 Charles Lambert ......... | 104 | 512 | 11 | 8 |
| 11 Newton, Keates & Co.... | — | — | | |
| 12 Sweetland, Tuttle & Co. | 30 | 50 | 11 | 0 |
| 13 Neath Copper Co. ......... | — | — | | |
| 14 Penclawdd Copper Co.... | — | — | | |
| Total.................. | 2,747 | £15,181 | 2 | 6 |

Average Produce, 7¾.
Quantity of Fine Copper, 201 tons 1 cwt.

Average Standard ......................... £113 1 0
Average Price per ton .................. 5 10 6

# Sundry Copper Ore Sales.

| Dates. | Mines. | Tons. | c. | q. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept. 28. | Okel Tor.............................. | 70 | 13 | 2 | — | | | Landore Works ......... | 229 | 11 | 5 |
| „ 30. | Knockmahon (ex Fairy)......... | 66 | 0 | 0 | 4 | 3 | 6 | Par Copper Works... | 544 | 10 | 0 |
| | „ „ ......... | 66 | 0 | 0 | 4 | 1 | 6 | St. Helen's Co. ...... | | | |
| | W. Canada Co. (ex Chancellor) | 40 | 0 | 0 | 16 | 11 | 6 | Bibby, Sons, & Co. | 8,539 | 5 | 0 |
| | „ „ | 40 | 0 | 0 | 16 | 14 | 0 | ditto | | | |
| | „ (ex Great Eastern) | 68 | 0 | 0 | 16 | 12 | 0 | ditto | | | |
| | „ „ | 68 | 0 | 0 | 16 | 12 | 6 | ditto | | | |
| | „ „ | 68 | 0 | 0 | 16 | 15 | 6 | ditto | | | |
| | „ „ | 68 | 0 | 0 | 16 | 13 | 6 | ditto | | | |
| | „ „ | 54 | 0 | 0 | 16 | 11 | 6 | ditto | | | |
| | „ „ | 54 | 0 | 0 | 16 | 9 | 6 | ditto | | | |
| | „ „ | 54 | 0 | 0 | 16 | 9 | 6 | ditto | | | |
| Oct. 20. | Parys .................................. | 165 | 0 | 0 | 5 | 10 | 6 | St. Helen's Co. ...... | 2,565 | 5 | 0 |
| | „ .................................. | 165 | 0 | 0 | 5 | 10 | 6 | Mona Co. ............... | | | |
| | „ .................................. | 140 | 0 | 0 | 2 | 13 | 0 | C. Lambert ............ | | | |
| | „ .................................. | 140 | 0 | 0 | 2 | 13 | 0 | Mona Co. ............... | | | |

# Copper Ores.

Sampled Sept. 16, and sold at Tabb's Hotel, Redruth, Oct. 1.

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| Clifford Amalgamated | 110 | 2, 5 | £5 | 2 | 0 |
| | 93 | 1 | 4 | 9 | 6 |
| | 71 | 1, 5, 6 | 8 | 0 | 6 |
| | 70 | 12 | 4 | 1 | 6 |
| | 69 | 1 | 6 | 12 | 6 |
| | 57 | 6 | 4 | 13 | 0 |
| | 54 | 6 | 4 | 12 | 6 |
| | 51 | 6 | 4 | 19 | 6 |
| | 39 | 1 | 4 | 11 | 0 |
| | 29 | 1 | 5 | 8 | 6 |
| | 24 | 12 | 2 | 3 | 0 |
| | 23 | 5 | 4 | 15 | 6 |
| (Consols) | 28 | 6 | 7 | 3 | 6 |
| | 2 | 1, 5 | 47 | 5 | 6 |
| West Seton ............ | 74 | 9 | 5 | 1 | 6 |
| | 73 | 12 | 2 | 3 | 6 |
| | 71 | 3 | 7 | 1 | 0 |
| | 62 | 3 | 4 | 11 | 0 |
| | 60 | 3 | 6 | 2 | 0 |
| | 56 | 3 | 4 | 10 | 6 |
| | 45 | 5 | 6 | 18 | 6 |
| | 40 | 3 | 6 | 18 | 0 |
| | 28 | 9 | 7 | 6 | 6 |
| Wheal Seton ............ | 46 | 7 | 5 | 6 | 6 |
| (Pendarves) | 121 | 12 | 1 | 7 | 6 |
| | 100 | 2 | 4 | 15 | 6 |
| | 97 | 7 | 5 | 9 | 6 |
| | 61 | 6 | 5 | 8 | 0 |
| | 24 | 3 | 12 | 16 | 6 |
| East Pool ............... | 86 | 7, 9 | 3 | 18 | 0 |
| | 55 | 8, 12, 14 | 0 | 3 | 6 |
| | 53 | 10 | 2 | 12 | 6 |
| | 52 | 5 | 3 | 14 | 0 |
| | 47 | 8 | 2 | 11 | 6 |
| | 34 | 10 | 2 | 12 | 6 |
| Fowey Consols ......... | 77 | 1 | £6 | 13 | 6 |
| | 75 | 6 | 4 | 11 | 6 |
| | 72 | 1 | 5 | 2 | 0 |
| | 46 | 1 | 1 | 0 | 6 |
| Wheal Basset ......... | 73 | 5 | 5 | 7 | 6 |
| | 60 | 5 | 5 | 2 | 0 |
| | 44 | 1, 5, 6 | 10 | 18 | 0 |
| South Frances ......... | 48 | 9 | 5 | 7 | 6 |
| | 43 | 7 | 6 | 9 | 0 |
| | 23 | 9 | 6 | 10 | 6 |
| | 15 | 9 | 4 | 2 | 6 |
| | 2 | 12 | 5 | 13 | 6 |
| Dolcoath.................. | 58 | 10 | 4 | 3 | 6 |
| | 36 | 7 | 5 | 0 | 6 |
| Tincroft .................. | 51 | 12 | 2 | 2 | 0 |
| | 39 | 5 | 5 | 4 | 6 |
| East Basset ............ | 32 | 7 | 11 | 9 | 0 |
| | 27 | 1, 5, 6 | 7 | 4 | 6 |
| | 25 | 7 | 7 | 9 | 0 |
| South Tolgus............ | 83 | 5 | 4 | 1 | 0 |
| South Crofty............ | 39 | 9, 10 | 1 | 9 | 0 |
| | 18 | 6 | 4 | 7 | 0 |
| | 15 | 6 | 4 | 3 | 0 |
| Stray Park............... | 35 | 1 | 2 | 10 | 6 |
| | 22 | 2, 6 | 7 | 10 | 6 |
| Condurrow ............ | 42 | 7 | 4 | 9 | 0 |
| | 4 | 6 | 8 | 3 | 0 |
| North Roskear ......... | 30 | 1 | 8 | 10 | 6 |
| Camborne Vean ...... | 20 | 7 | 3 | 9 | 0 |
| Carn Camborne ...... | 10 | 5 | 3 | 5 | 0 |
| | 6 | 5 | 9 | 1 | 0 |
| | 2 | 5 | 5 | 12 | 0 |
| Illogan Mines ......... | 13 | 5 | 2 | 12 | 6 |
| Wheal Kitty ............ | 12 | 5 | 7 | 0 | 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Clifford Amalgamated ... | 720 | £3,949 | 10 | 0 |
| West Seton .................. | 509 | 2,729 | 2 | 0 |
| Wheal Seton ............... | 449 | 2,057 | 2 | 0 |
| East Pool .................. | 327 | 886 | 16 | 6 |
| Fowey Consols ........... | 270 | 1,271 | 9 | 0 |
| Wheal Basset ............... | 177 | 1,177 | 19 | 6 |
| South Frances ............ | 131 | 758 | 13 | 0 |
| Dolcoath ........ .......... | 94 | 423 | 1 | 0 |
| Tincroft .................... | 90 | 310 | 17 | 6 |
| East Basset................. | 84 | 747 | 14 | 6 |
| South Tolgus .................. | 83 | £336 | 3 | 0 |
| South Crofty ................. | 72 | 197 | 2 | 0 |
| Stray Park ..................... | 57 | 253 | 18 | 6 |
| Condurrow ..................... | 46 | 219 | 10 | 0 |
| North Roskear .............. | 30 | 255 | 15 | 0 |
| Camborne Vean.............. | 20 | 69 | 0 | 0 |
| Carn Camborne .............. | 18 | 98 | 0 | 0 |
| Illogan Mines................. | 13 | 34 | 2 | 6 |
| Wheal Kitty ................. | 12 | 84 | 0 | 0 |

## EACH COMPANY'S PURCHASE.

| | | Tons. | Amount. | | |
|---|---|---|---|---|---|
| 1 | Vivian and Sons ......... | 538½ | £2,942 | 12 | 4 |
| 2 | Freeman and Co. ...... | 166 | 840 | 15 | 6 |
| 3 | Grenfell and Sons ...... | 313 | 1,985 | 17 | 0 |
| 4 | Crown Copper Co. ...... | — | —— | | |
| 5 | Sims, Willyams & Co. ... | 521½ | 2,810 | 17 | 4 |
| 6 | Williams, Foster & Co. | 421½ | 2,312 | 13 | 10 |
| 7 | Mason and Elkington ... | 384 | 2,210 | 10 | 6 |
| 8 | Bankart and Sons ...... | 65½ | 124 | 8 | 0 |
| 9 | Copper Miners' Co. ...... | 250½ | £1,246 | 11 | 6 |
| 10 | Charles Lambert ......... | 164½ | 498 | 16 | 0 |
| 11 | Newton, Keates & Co... | — | —— | | |
| 12 | Sweetland, Tuttle & Co. | 359½ | 783 | 13 | 2 |
| 13 | Neath Copper Co. ...... | — | —— | | |
| 14 | Penclawdd Copper Co. | 18½ | 3 | 4 | 2 |
| | Total .............. | 3,202 | £15,759 | 16 | 0 |

Average Produce, 6½.
Quantity of Fine Copper, 208 tons 17 cwts.

Average Standard ..................£117 12 0
Average Price per ton ............ 4 18 6

# Copper Ores.

**Sampled Sept. 23, and sold at Tabb's Hotel, Redruth, Oct. 8.**

| Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|
| West Basset ............ | 74 | 11 | £6 6 6 |
| | 71 | 1, 6 | 9 7 6 |
| | 67 | 6 | 4 5 6 |
| | 59 | 9 | 6 5 6 |
| | 56 | 3 | 3 17 6 |
| | 50 | 5 | 9 5 0 |
| | 36 | 9 | 4 11 0 |
| Prosper United......... | 77 | 12 | 3 17 6 |
| | 53 | 1 | 3 0 0 |
| | 47 | 5 | 2 2 0 |
| | 36 | 2 | 4 16 0 |
| Carn Brea ................ | 49 | 1, 6 | 7 17 6 |
| | 48 | 10 | 3 6 0 |
| | 43 | 11 | 5 16 6 |
| | 36 | 10 | 3 11 6 |
| | 25 | 1, 3, 10 | 1 4 0 |
| Par Consols ............ | 73 | 6 | 7 12 6 |
| | 65 | 2 | 6 0 6 |
| | 37 | 3 | 4 10 0 |
| East Carn Brea......... | 46 | 7 | 5 7 6 |
| | 43 | 7 | 5 1 0 |
| | 26 | 7 | 6 8 6 |
| Copper Hill ............ | 62 | 12 | 1 13 0 |
| | 44 | 5 | 7 11 0 |
| Great South Tolgus ... | 59 | 7 | 7 14 0 |
| Great South Tolgus ... | 43 | 1, 3, 6 | £10 13 0 |
| Rosewarne Consols ... | 41 | 5, 8 | 4 2 6 |
| | 28 | 5 | 6 6 0 |
| | 20 | 5 | 7 4 6 |
| Charlotte United ...... | 37 | 9 | 7 0 6 |
| | 28 | 6, 7 | 6 12 0 |
| | 23 | 1 | 3 10 0 |
| Treloweth ............... | 36 | 12, 14 | 3 10 6 |
| | 25 | 11 | 4 14 0 |
| | 14 | 1 | 8 14 6 |
| Rosewarne United ... | 34 | 6 | 10 2 0 |
| | 32 | 3 | 2 14 0 |
| Wheal Buller............ | 44 | 3 | 2 12 6 |
| | 11 | 3 | 12 2 0 |
| Pendeen Consols ...... | 55 | 1 | 3 2 0 |
| West Fowey Consols | 53 | 1, 6 | 8 17 6 |
| Great Work ............ | 15 | 6 | 5 19 6 |
| | 1 | 5 | 30 14 0 |
| South Dolcoath.......... | 16 | 14 | 15 10 6 |
| Wheal Florence ...... | 13 | 14 | 5 7 6 |
| | 3 | 5 | 6 9 6 |
| New Rosewarne ...... | 8 | 7 | 5 19 0 |
| | 4 | 5 | 12 15 0 |
| Camborne Consols ... | 10 | 5 | 7 5 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. |
|---|---|---|
| West Basset .................. | 413 | £2,633 12 6 |
| Prosper United............... | 213 | 728 17 6 |
| Carn Brea ...................... | 201 | 953 9 0 |
| Par Consols .................. | 175 | 1,114 15 0 |
| East Carn Brea ............ | 115 | 631 9 0 |
| Copper Hill .................. | 106 | 434 10 0 |
| Great South Tolgus ......... | 102 | 912 5 0 |
| Rosewarne Consols ......... | 89 | 490 0 6 |
| Charlotte United ............ | 88 | 525 4 6 |
| Treloweth ...................... | 75 | 366 11 0 |
| Rosewarne United ......... | 66 | £429 16 0 |
| Wheal Buller.................. | 55 | 248 12 0 |
| Pendeen Consols ............ | 55 | 170 10 0 |
| West Fowey Consols ...... | 53 | 470 7 6 |
| Great Work .................. | 16 | 120 6 6 |
| South Dolcoath.... .......... | 16 | 248 8 0 |
| Wheal Florence ............ | 16 | 89 6 0 |
| New Rosewarne ............ | 12 | 96 12 0 |
| Camborne Consols ......... | 10 | 72 10 0 |

## EACH COMPANY'S PURCHASE.

| | | Tons. | Amount. |
|---|---|---|---|
| 1 | Vivian and Sons ............ | $254\frac{1}{8}$ | £1,455 14 9 |
| 2 | Freeman and Co. ......... | 101 | 564 8 6 |
| 3 | Grenfell and Sons ......... | $202\frac{7}{8}$ | 881 3 0 |
| 4 | Crown Copper Co. ......... | — | —— |
| 5 | Sims, Willyams & Co. ... | $227\frac{3}{8}$ | 1,472 9 9 |
| 6 | Williams, Foster & Co. ... | $303\frac{5}{8}$ | 2,282 1 3 |
| 7 | Mason and Elkington ... | 196 | 1,225 15 0 |
| 8 | Bankart and Sons ... ..... | $20\frac{5}{8}$ | 84 11 3 |
| 9 | Copper Miners' Co. . ... | 132 | £793 19 |
| 10 | Charles Lambert......... | $92\frac{3}{8}$ | 297 2 0 |
| 11 | Newton, Keates & Co. | 142 | 836 0 6 |
| 12 | Sweetland, Tuttle & Co. | 157 | 364 2 6 |
| 13 | Neath Copper Co. ...... | — | —— |
| 14 | Penclawdd Copper Co. | 47 | 381 14 6 |
| | Total ............... | 1,876 | £10,739 2 0 |

Average Produce, $7\frac{1}{4}$.
Quantity of Fine Copper, 136 tons 10 cwts.

Average Standard ................. £116 9 0
Average Price per ton ............ 5 14 6

No Sale on Oct. 15th.

# Copper Ores.

**Sampled Oct. 7, and sold at the Royal Hotel, Truro, Oct. 22.**

| Mines. | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| Devon Great Consols... | 139 | 8 | £5 | 9 | 6 |
| | 135 | 4, 6, 9 | 5 | 11 | 6 |
| | 133 | 4, 6 | 4 | 8 | 0 |
| | 130 | 2 | 5 | 5 | 0 |
| | 125 | 1 | 3 | 19 | 6 |
| | 118 | 1, 6 | 3 | 5 | 6 |
| | 114 | 6 | 6 | 5 | 6 |
| | 113 | 1 | 5 | 6 | 6 |
| | 111 | 11 | 5 | 2 | 6 |
| | 105 | 3, 5 | 5 | 2 | 0 |
| | 102 | 4, 6 | 6 | 0 | 6 |
| | 101 | 1, 5 | 5 | 3 | 0 |
| | 99 | 1 | 4 | 19 | 0 |
| | 88 | 5 | 4 | 7 | 0 |
| | 87 | 10 | 1 | 7 | 0 |
| | 86 | 10 | 2 | 6 | 0 |
| | 82 | 1 | 3 | 6 | 6 |
| | 78 | 1, 5, 6 | 1 | 11 | 6 |
| | 77 | 2, 5 | 4 | 9 | 6 |
| | 76 | 5 | 1 | 9 | 6 |
| | 60 | 1, 6 | 8 | 15 | 6 |
| | 51 | 1, 6 | 13 | 5 | 6 |
| | 47 | 1, 6 | 12 | 15 | 6 |
| | 46 | 5 | 5 | 16 | 0 |
| | 45 | 1 | 2 | 3 | 0 |
| | 35 | 1, 6 | 2 | 14 | 6 |
| | 20 | 1 | 15 | 5 | 6 |
| East Caradon ... ........ | 90 | 4, 6 | 5 | 16 | 6 |
| | 89 | 2 | 4 | 10 | 6 |
| | 80 | 4, 6 | 5 | 4 | 6 |
| | 78 | 1, 6 | 7 | 14 | 6 |
| | 62 | 6 | 5 | 5 | 6 |
| | 61 | 6 | 8 | 9 | 6 |
| | 45 | 6 | 8 | 0 | 6 |
| Phœnix Mines ......... | 119 | 5 | 2 | 6 | 0 |
| Phœnix Mines ......... | 106 | 7, 9 | £6 | 14 | 6 |
| | 102 | 2 | 5 | 10 | 0 |
| | 68 | 6, 9, 12 | 3 | 3 | 6 |
| | 65 | 7, 9 | 7 | 5 | 6 |
| Marke Valley ............ | 87 | 5 | 3 | 11 | 0 |
| | 82 | 5 | 3 | 16 | 0 |
| | 80 | 5 | 3 | 16 | 0 |
| | 65 | 9 | 3 | 9 | 0 |
| | 40 | 2 | 6 | 11 | 6 |
| | 35 | 5 | 3 | 1 | 0 |
| | 31 | 5 | 3 | 1 | 0 |
| Devon and Cornwall... | 80 | 5, 12 | 1 | 18 | 0 |
| | 69 | 5 | 2 | 15 | 0 |
| | 54 | 5 | 1 | 4 | 6 |
| | 35 | 3 | 10 | 17 | 6 |
| | 32 | 3 | 6 | 11 | 0 |
| Bedford United ......... | 108 | 9 | 4 | 12 | 0 |
| | 98 | 7 | 5 | 7 | 6 |
| Wheal Friendship ...... | 70 | 1, 6 | 9 | 16 | 6 |
| | 50 | 1, 6 | 6 | 14 | 6 |
| Wheal Emma ............ | 52 | 1 | 1 | 10 | 6 |
| | 34 | 6 | 5 | 13 | 0 |
| | 30 | 12 | 2 | 12 | 6 |
| Brookwood ............... | 38 | 1, 12 | 3 | 4 | 6 |
| | 37 | 9 | 7 | 5 | 6 |
| | 36 | 1 | 3 | 6 | 6 |
| Wheal Arthur............ | 45 | 7 | 6 | 2 | 6 |
| | 23 | 9 | 1 | 16 | 6 |
| North Wheal Robert... | 60 | 4, 6 | 5 | 14 | 6 |
| Sortridge Consols ...... | 23 | 11 | 4 | 12 | 6 |
| | 15 | 11 | 9 | 15 | 0 |
| Collacombe ............... | 27 | 5 | 3 | 9 | 6 |
| Fursdon ................... | 26 | 11, 12 | 5 | 6 | 6 |
| Rabey's Ore............... | 4 | 1 | 10 | 14 | 0 |
| Wellington's Ore ...... | 3 | 9 | 7 | 18 | 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Devon Great Consols... | 2,403 | £11,829 | 9 | 6 |
| East Caradon ............ | 505 | 3,152 | 13 | 6 |
| Phœnix...................... | 460 | 2,236 | 6 | 6 |
| Marke Valley ............ | 420 | 1,613 | 0 | 0 |
| Devon & Cornwall ...... | 270 | 998 | 2 | 6 |
| Bedford United ......... | 206 | 1,023 | 11 | 0 |
| Wheal Friendship ...... | 120 | 1,024 | 0 | 0 |
| Wheal Emma ............ | 116 | 350 | 3 | 0 |
| Brookwood .................. | 111 | £511 | 8 | 6 |
| Wheal Arthur ............... | 68 | 317 | 12 | 0 |
| North Wheal Robert ...... | 60 | 343 | 10 | 0 |
| Sortridge Consols............ | 38 | 252 | 12 | 6 |
| Collacombe .................. | 27 | 93 | 16 | 6 |
| Fursdon ........................ | 26 | 138 | 9 | 0 |
| Rabey's Ore .................. | 4 | 42 | 16 | 0 |
| Wellington's Ore ............ | 3 | 23 | 14 | 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| 1 Vivian and Sons ......... | 926 | £4,823 | 16 | 3 |
| 2 Freeman and Co. ......... | 399½ | 2,081 | 10 | 3 |
| 3 Grenfell and Sons ......... | 258¾ | 1,619 | 0 | 0 |
| 4 Crown Copper Co.......... | 277¼ | 1,493 | 12 | 6 |
| 5 Sims, Willyams & Co. ... | 1,001¾ | 3,327 | 18 | 9 |
| 6 Williams, Foster & Co. ... | 874 | 5,603 | 6 | 9 |
| 7 Mason and Elkington ... | 228¼ | 1,395 | 4 | 9 |
| 8 Bankart and Sons ......... | — | — | | |
| 9 Copper Miners' Co. ...... | 400½ | £2,007 | 11 | 9 |
| 10 Charles Lambert ......... | 173 | 315 | 5 | 0 |
| 11 Newton, Keates & Co.... | 162 | 890 | 14 | 6 |
| 12 Sweetland, Tuttle & Co. | 136 | 393 | 4 | 0 |
| 13 Penclawdd Copper Co. | — | — | | |
| Total ............... | 4,837 | £23,951 | 4 | 6 |

Average Produce, 6⅛.
Quantity of Fine Copper, 297 tons 10 cwts.

Average Standard ............... £125 4 0
Average Price per ton ............ 4 19 6

# Copper Ores.

**Sampled Sept. 16, and sold at Swansea, Oct. 6.**

| Mines. | Tons. | Produce. | Purchasers. | Price. | | |
|---|---|---|---|---|---|---|
| Cuba | 100 | 13¼ | 7 | £11 | 0 | 6 |
| | 96 | 13½ | 11 | 10 | 14 | 0 |
| (Precipitate) | 12 | 64⅝ | 10 | 51 | 5 | 6 |
| (Dust) | 95 | 13¼ | 6 | 11 | 2 | 0 |
| | 90 | 13¾ | 6 | 11 | 7 | 0 |
| (Precipitate) | 10 | 66 | 10 | 52 | 3 | 6 |
| | 8 | 64⅞ | 10 | 52 | 3 | 6 |
| (Dust) | 76 | 13¾ | 3 | 11 | 10 | 6 |
| (Stone) | 42 | 20⅝ | 3 | 17 | 12 | 0 |
| | 26 | 18½ | 5 | 15 | 4 | 0 |
| (Precipitate) | 7 | 66½ | 5 | 58 | 0 | 0 |
| | 6 | 76½ | 5 | 62 | 17 | 0 |
| Cape Copper | 50 | 33⅛ | 6 | 28 | 4 | 0 |
| | 42 | 33 | 6 | 28 | 4 | 0 |
| | 23 | 31¾ | 16 | 27 | 2 | 6 |
| | 5 | 48⅛ | 16 | 41 | 17 | 6 |
| | 10 | 16 | 16 | 13 | 7 | 6 |
| Berehaven | 101 | 10⅛ | 15 | 9 | 4 | 0 |
| | 104 | 10½ | 2 | 8 | 13 | 0 |
| | 64 | 10⅝ | 7 | 9 | 10 | 6 |
| | 125 | 10⅞ | 7 | 9 | 2 | 0 |
| Knockmahon | 126 | 13⅜ | 11 | 11 | 16 | 0 |
| Knockmahon | 85 | 12 | 13 | £9 | 7 | 0 |
| | 42 | 10 | 13 | 8 | 2 | 6 |
| Laxey | 146 | 6⅝ | 3 | 5 | 5 | 0 |
| Norway | 90 | ⅜ | 6 | 0 | 5 | 0 |
| | 10 | 1¼ | 6 | 0 | 17 | 0 |
| Cappagh | 53 | 9½ | 7, 13 | 8 | 1 | 6 |
| | 32 | 5⅛ | 7 | 4 | 0 | 0 |
| | 2 | 39¼ | 5 | 33 | 1 | 0 |
| Italian Ore | 17 | 13¼ | 7 | 10 | 17 | 0 |
| Cronebane | 2 | 18 | 6 | 14 | 0 | 0 |
| | 1 | 8 | 2 | 6 | 10 | 0 |
| Tigrony | 2 | 17 | 10 | 13 | 10 | 6 |
| | 1 | 8 | 2 | 6 | 10 | 0 |
| Bathurst | 2 | 22 | 2 | 18 | 19 | 0 |
| British Regulus | 50 | 33⅛ | 10 | 26 | 5 | 6 |
| Moonta | 78 | 14⅝ | 1 | 11 | 15 | 6 |
| | 47 | 14⅛ | 3 | 11 | 10 | 0 |
| | 40 | 21⅛ | 3 | 17 | 19 | 0 |
| | 10 | 12⅛ | 1, 3 | 9 | 18 | 0 |
| | 7 | 18⅛ | 3 | 15 | 10 | 0 |
| Connorree | 53 | 3½ | 2 | 2 | 7 | 0 |
| London | 115 | 3⅜ | 7 | 2 | 7 | 0 |

TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Cuba | 568 | £8,518 | 11 | 0 |
| Cape Copper | 130 | 3,561 | 9 | 0 |
| Berehaven | 394 | 3,575 | 15 | 0 |
| Knockmahon | 253 | 2,622 | 16 | 0 |
| Laxey | 146 | 766 | 10 | 0 |
| Norway | 100 | 31 | 0 | 0 |
| Cappagh | 87 | 622 | 1 | 6 |
| Italian Ore | 17 | 184 | 9 | 0 |
| Cronebane | 3 | £34 | 10 | 0 |
| Tigrony | 3 | 33 | 11 | 0 |
| Bathurst | 2 | 37 | 18 | 0 |
| British Regulus | 50 | 1,313 | 15 | 6 |
| Moonta | 182 | 2,384 | 9 | 0 |
| Connorree | 53 | 124 | 11 | 0 |
| London | 115 | 270 | 5 | 0 |

EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| 1 Copper Miners' Co. | 83 | £967 | 19 | 0 |
| 2 Freeman and Co. | 161 | 1,075 | 1 | 0 |
| 3 P. Grenfell and Sons | 363 | 3,798 | 2 | 0 |
| 4 Crown Copper Co. | — | —— | | |
| 5 Sims, Willyams, Nevill & Co. | 41 | 1,209 | 8 | 0 |
| 6 Vivian and Sons | 379 | 4,729 | 8 | 0 |
| 7 Williams, Foster & Co. | 479½ | 3,646 | 5 | 9 |
| 8 British and Foreign | — | —— | | |
| 9 Mason and Elkington | — | —— | | |
| 10 Bankart and Sons | 82 | £2,895 | 5 | 0 |
| 11 Charles Lambert | 222 | 2,514 | 0 | 0 |
| 12 Ravenhead Copper Co. | — | —— | | |
| 13 Sweetland, Tuttle & Co. | 153½ | 1,349 | 19 | 9 |
| 14 Jennings & Co. | — | —— | | |
| 15 Neath Copper Co. | 101 | 929 | 4 | 0 |
| 16 Penclawdd Copper Co. | 88 | 967 | 1 | 0 |
| Total | 2,103 | £24,081 | 13 | 6 |

No Sale on Oct. 20th.

# Black Tin Sales.

| Dates. | | Mines. | Tons | c. | q. | lbs. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept. | 9. | Leeds and St. Aubyn | 4 | 4 | 0 | 18 | 68 | 5 | 0 | Chyandour | 287 | 4 | 0 |
| ,, | 16. | St. Day United | 35 | 19 | 3 | 6 | — | | | — | 2093 | 2 | 3 |
| | | North Basset | 2 | 19 | 1 | 22 | 64 | 5 | 0 | Harvey & Co. | 190 | 19 | 5 |
| ,, | 18. | Trevenen | 5 | 6 | 3 | 16 | 72 | 0 | 0 | Enthoven & Sons | 425 | 3 | 0 |
| | | ,, | 0 | 13 | 1 | 26 | 45 | 0 | 0 | ditto | | | |
| ,, | 22. | Gurlyn | 8 | 0 | 3 | 21 | 67 | 12 | 6 | Chyandour | 544 | 3 | 0 |
| ,, | 23. | Bagtor | 1 | 4 | 0 | 6 | 67 | 0 | 0 | Harvey & Co. | 80 | 11 | 7 |
| ,, | 24. | Leeds and St. Aubyn | 4 | 18 | 0 | 27 | 68 | 5 | 0 | Chyandour | 335 | 5 | 0 |
| ,, | 25. | Cornubia | 4 | 0 | 3 | 27 | 67 | 0 | 0 | Daubuz & Co. | 271 | 6 | 5 |
| ,, | 30. | Great Wheal Busy | 17 | 11 | 1 | 20 | — | | | — | 1052 | 13 | 11 |
| Oct. | 1. | Prosper United | 13 | 1 | 1 | 8 | — | | | — | 870 | 12 | 0 |
| ,, | 4. | Phœnix | 12 | 1 | 1 | 21 | 64 | 0 | 0 | Bissoe Co. | 772 | 12 | 0 |
| ,, | 6. | Cuddra | 6 | 1 | 1 | 13 | 69 | 0 | 0 | Trethellan Co. | 432 | 4 | 3 |
| | | ,, | 0 | 6 | 0 | 0 | 45 | 0 | 0 | ditto | | | |
| ,, | 14. | Graet Wh. Vor United | 31 | 8 | 1 | 0 | — | | | — | 2169 | 4 | 3 |
| | | Pedn-an-drea | 9 | 19 | 0 | 6 | — | | | Bissoe Co. | 662 | 8 | 8 |
| | | Retanna Hill | 1 | 0 | 2 | 3 | 64 | 10 | 0 | Bolitho & Sons | 68 | 12 | 6 |
| | | ,, | 0 | 1 | 1 | 11 | 36 | 0 | 0 | ditto | | | |
| ,, | 16. | Trevenen | 5 | 19 | 0 | 3 | 72 | 10 | 0 | Enthoven & Sons | 461 | 16 | 6 |
| | | ,, | 0 | 13 | 1 | 27 | 45 | 0 | 0 | ditto | | | |
| | | Wheal Vyvyan | 2 | 0 | 1 | 12 | 65 | 10 | 0 | Harvey & Co. | 151 | 0 | 2 |
| | | ,, | 0 | 9 | 0 | 6 | 41 | 12 | 6 | ditto | | | |
| ,, | 17. | Penhalls | 3 | 11 | 2 | 19 | — | | | — | 243 | 4 | 7 |
| | | St. Day United | 46 | 11 | 1 | 1 | — | | | — | 2770 | 15 | 3 |
| ,, | 19. | East Wheal Grenville | 3 | 16 | 1 | 19 | 70 | 0 | 0 | Mellanear | 267 | 9 | 4 |

# Lead Ore Sales.

| Dates. | Mines. | Tons. | Price per Ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|
| Sept. 17. | Carmarthen United | 36 | 13 | 10 | 6 | Panther Co. | 486 | 18 | 0 |
| " 24. | Westminster | 36 | 13 | 1 | 0 | A. Eyton | 470 | 16 | 0 |
| | Mount Pleasant | 12 | 12 | 16 | 6 | ditto | 153 | 18 | 0 |
| | Hendre Ucha | 10 | 12 | 14 | 0 | Newton, Keates & Co. | 127 | 0 | 0 |
| | Bryngwyn | 9 | 13 | 11 | 0 | Walker, Parker & Co. | 221 | 3 | 6 |
| | " | 7 | 14 | 3 | 6 | Newton, Keates & Co. | | | |
| | Pant-y-Mwyn | 8 | 12 | 8 | 6 | ditto | 99 | 8 | 0 |
| | Maudlin | 7 | 12 | 16 | 6 | Walker, Parker & Co. | 89 | 15 | 6 |
| | Caeconroy | 6 | 14 | 14 | 6 | A. Eyton | 88 | 7 | 0 |
| | Roman Gravels | 21 | 13 | 0 | 0 | Newton, Keates & Co. | 273 | 0 | 0 |
| " 28. | Castleward United | 26 | 10 | 11 | 0 | Mining Co. of Ireland | 274 | 6 | 0 |
| | East Logylas | 42 | 12 | 16 | 0 | Newton, Keates & Co. | 537 | 12 | 0 |
| | Glogfach | 60 | 16 | 13 | 6 | Walker, Parker & Co. | 1,000 | 10 | 0 |
| | Cwmystwith | 112½ | 12 | 13 | 6 | Panther Co. | 1,901 | 5 | 0 |
| | " | 37½ | 12 | 13 | 6 | Sims, Willyams & Co. | | | |
| | Goginan | 23 | 17 | 3 | 6 | ditto | 525 | 0 | 6 |
| | " | 8 | 16 | 5 | 0 | Newton, Keates & Co. | | | |
| " 30. | Bronfloyd | 60 | 13 | 9 | 0 | Panther Co. | 807 | 0 | 0 |
| Oct. 1. | Dyliffe | 45 | 13 | 6 | 0 | Newton, Keates & Co. | 598 | 10 | 0 |
| " 2. | Minera | 50 | 13 | 7 | 6 | Walker, Parker & Co. | 6,161 | 5 | 0 |
| | " | 50 | 13 | 7 | 6 | Newton, Keates & Co. | | | |
| | " | 100 | 13 | 7 | 6 | Walker, Parker & Co. | | | |
| | " | 42½ | 13 | 7 | 6 | ditto | | | |
| | " | 42½ | 13 | 7 | 6 | Newton, Keates & Co. | | | |
| | " | 100 | 13 | 8 | 6 | Walker, Parker & Co. | | | |
| | " | 75 | 13 | 8 | 6 | ditto | | | |
| " 7. | Wheal Mary Ann | 52 | 26 | 10 | 0 | Stock & Co. | 1,651 | 10 | 0 |
| | " | 20 | 13 | 13 | 6 | Treffry's Trustees | | | |
| " 8. | Talargoch (Maesyrerwddu) | 47 | 13 | 15 | 6 | A. Eyton | 647 | 8 | 6 |
| | " (Coetia Llys) | 138 | 14 | 14 | 6 | Walker, Parker & Co. | 2,032 | 1 | 0 |
| | Deep Level | 15 | 13 | 1 | 6 | ditto | 196 | 2 | 6 |
| | Brynford Hall | 3 | 13 | 0 | 0 | Newton, Keates & Co. | 39 | 0 | 0 |
| | Rhosesmor | 63 | 12 | 16 | 0 | A. Eyton | 806 | 8 | 0 |
| | Parry's | 30 | 13 | 9 | 0 | Newton, Keates & Co. | 403 | 10 | 0 |
| | Bryn Gwiog | 50 | 13 | 17 | 6 | Walker, Parker & Co. | 693 | 15 | 0 |
| | Long Rake | 20 | 13 | 6 | 6 | Newton, Keates & Co. | 266 | 10 | 0 |
| | Merllyn | 7 | 13 | 9 | 0 | ditto | 94 | 3 | 0 |
| | Speedwell | 11 | 12 | 11 | 6 | Walker, Parker & Co. | 138 | 6 | 6 |
| | Llangynog United | 27 | 12 | 11 | 0 | ditto | 338 | 17 | 0 |
| | Llanerchyraur | 20 | 13 | 8 | 6 | ditto | 268 | 10 | 0 |
| | Pwllclar | 7 | 12 | 15 | 6 | Newton, Keates & Co. | 89 | 8 | 6 |
| | Chware Las | 10 | 13 | 18 | 0 | ditto | 139 | 0 | 0 |
| | Minera Union | 15 | 14 | 0 | 0 | Jenkins Brothers | 210 | 0 | 0 |
| | Isle of Man Mining Co. | 100 | 21 | 16 | 6 | Walker, Parker & Co. | 2,182 | 10 | 0 |
| | North Minera | 14 | 12 | 10 | 0 | Newton, Keates & Co. | 175 | 0 | 0 |
| " 10. | Cargoll | 32 | 16 | 1 | 0 | Michell & Son | 1,102 | 5 | 0 |
| | " | 32 | 15 | 16 | 0 | Panther Co. | | | |
| | " | 11 | 7 | 11 | 0 | Michell & Son | | | |
| " 12. | Frongoch | 146 | 12 | 15 | 6 | Sims, Willyams & Co. | 1,865 | 3 | 0 |
| | East Darren | 75 | 16 | 2 | 6 | Newton, Keates & Co. | 1,209 | 7 | 6 |
| | Cwm Erfin | 25 | 16 | 1 | 6 | Michell & Co. | 968 | 0 | 0 |
| | " | 35 | 16 | 3 | 6 | Treffry's Trustees | | | |
| " 15. | Dyliffe | 20 | 13 | 2 | 0 | A. Eyton | 524 | 0 | 0 |
| | " | 20 | 13 | 2 | 0 | Newton, Keates & Co. | | | |
| | Roman Gravels | 21 | 12 | 18 | 0 | ditto | 270 | 18 | 0 |
| | West Chiverton | 82 | 19 | 10 | 6 | — | 2,102 | 0 | 0 |
| | " | 43 | 11 | 13 | 0 | — | | | |
| " 17. | Twelve Apostles | 110 | 13 | 7 | 6 | A. Eyton | 1,542 | 10 | 0 |
| | " | 10 | 7 | 2 | 6 | ditto | | | |
| " 20. | Dyliffe | 64 | 13 | 7 | 6 | Walker, Parker, & Co. | 856 | 0 | 0 |
| | Dyfngwm | 37 | 13 | 0 | 6 | Newton, Keates, & Co. | 481 | 18 | 6 |
| | Aberdovey | 8 | 12 | 15 | 6 | ditto | 102 | 4 | 0 |
| | Nant-y-Iago | 14 | 12 | 8 | 0 | ditto | 173 | 12 | 0 |

THE

# MINING AND SMELTING MAGAZINE.

DECEMBER, 1863.

## The Manufacture of Aluminium,

### AT THE SALYNDRE WORKS,

*Département du Gard, France,*

BY A. STEVART, ELEVE INGENIEUR DES MINES.*

CONSIDERABLE progress has been made in the Manufacture of Aluminium at the Salyndre Chemical Works, of which the following is a succinct description—taking the operations methodically in their order of sequence.

It is here unnecessary to enter upon a history of this interesting branch of metallurgy; in M. Sainte-Claire Deville's memoir, published in 1859,† will be found a description of the numerous trials successively attempted at Javel, at Rouen, at Glacière, and at Nanterre, to find an industrial solution of the problem of extracting aluminium. We shall often refer back to this memoir respecting those methods still in use, our object here being to confine ourselves to a description of the improvements introduced on these methods.

The operations by which this metal is produced are divisible into three groups, which we shall class and describe under the three following sections.

§ I. Manufacture of the double chloride of Aluminium and Sodium.

§ II. Manufacture of the Sodium.

§ III. Manufacture of the Aluminium by the reaction of the two preceding bodies.

§ I.

The manufacture of the double chloride of Aluminium and Sodium requires the employment of an almost chemically pure alumina. M. Sainte-Claire Deville found this the most difficult portion of the

* *Revue Universelle*, 4th livraison of 1863.

† *De l'aluminium, ses propriétés, sa fabrication et ses applications.*—Paris, Mallet Bachelier.

manufacture—and the mode of obtaining this product, either from ammoniacal alum, or from the sulphate of alumina of commerce, left much to be desired both in respect of price and of purity.

At present we possess a valuable ore, furnishing pure alumina by two very simple operations, which now renders the preparation of aluminium a real metallurgical process, and no longer a mere laboratory operation, with complicated apparatus, like that described in the memoir mentioned. This ore, which is worked in the department of Var (in the gorges of the Ollioulles near Toulon), presents the appearance of a brecciaform mass, with small particles of a brownish or blackish-red colour disseminated in a very fine compact cement of a brick-red colour. Its average composition is:—

| | |
|---|---|
| Alumina .. .. .. .. .. | 60 |
| Ferric oxide .. .. .. .. .. | 25 |
| Silica .. .. .. .. .. .. | 3 |
| Water.. .. .. .. .. .. | 12 |
| | 100 |

By comparing this analysis, for which we are indebted to M. Balard, with the following composition of two *diaspores*—the one pure, and the other, brought from Siberia, mixed with iron—we find that this Salyndre ore may be assimilated with this mineral species by increasing the percentage of iron and decreasing that of alumina:—

| | Pure Diaspore. | Diaspore from Siberia. |
|---|---|---|
| Alumina .. .. .. .. | 85·10 | 74·66 |
| Ferric oxide .. .. .. | — | 4·51 |
| Silica .. .. .. .. | — | 2·90 |
| Lime and Magnesia .. .. | — | 14·58 |
| Water .. .. .. .. | 14·90 | 1·64 |
| | 100·00 | 98·29 |

The following is the simple treatment to which this ore is subjected to get rid of the iron and silica it contains:—

After being reduced to a fine powder under an edge stone, it is mixed with the salt of soda, and heated on the sole of a reverberatory furnace. The mass does not melt, or even become agglutinated; the combination is effected without any change of physical condition, and an aluminate of soda ($2Al^2O^3,3NaO$) and a double silicate of alumina and soda are obtained, mixed with oxide of iron, silica, and a little of the alumina which has not reacted.

In consequence of the state of disintegration which is thus preserved, the product is treated in water with great facility. This only *absolutely* dissolves the aluminate of soda, leaving in the residue the oxide of iron and the silica—the first free, the second partly transformed into a double silicite of soda and alumina. The old process had the grave defect of allowing a portion of the iron and the silica, derived from the impurities in the alumina, to pass into the aluminium

—both of which bodies are extremely injurious to this metal, diminishing its two most distinctive properties—that is, its lustre and its non-tarnishing property.

The extremely limpid solution of aluminate of soda is now decanted into a horizontal sheet-iron cylinder, in the axis of which a paddle-agitator works rapidly, throwing the liquid into suspension in the form of fine rain. A current of carbonic acid, obtained from a very pure white limestone treated with hydrochloric acid (which latter the works furnish in great quantity), is now brought in at the lower part, causing the following reaction:—

$$2Al^2O^3,3NaO + 3Co^2 = 3NaO,CO^2 + 2Al^2O^3.$$

The precipitated alumina is collected by decantation after settling, and washed with warm water to remove the last traces of soda. This washing is conducted very carefully in large sheet-iron filters, spread above a metallic vessel through which a strong draught is created by means of a current of steam. This suction is indispensable to render the slow operation of filtering and washing applicable on a large scale.

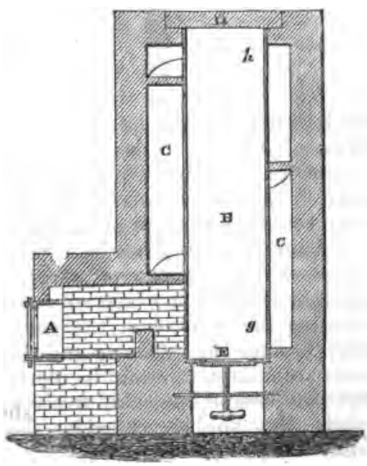
The products obtained are therefore:—

1. A solution of soda, which returns to the evaporating boilers of the works, so that no soda is lost except the small portion converted into silicates.

2. A very white paste of hydrated alumina, which is probably the purest product ever produced by a chemical process on a large scale. It may be stated, in passing, that various products, for dyers, have been prepared from this alumina—such as sulphate of alumina—which have an excellent sale on account of their complete freedom from iron. This of itself is a remarkable evidence of the progress recently made in this manufacture, for here we find that products are prepared from alumina (obtained as we have seen), while a few years ago alumina itself was attempted to be made from these very substances.

Returning to a description of the process:—the alumina is now completely dried and dishydrated in a small reverberatory furnace, to which it is charged in a state of mortar. After this, it is mixed with salt and a powder of wood charcoal; after which, with the assistance of a little water to moisten the whole, it is made into balls the size of the fist, which are dried in a stone, and then placed in the crucible of the furnace, which we proceed to describe.

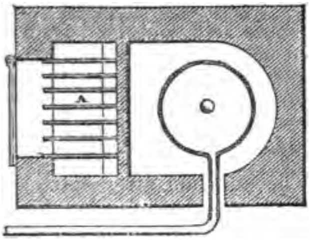
Fig. 11.




This furnace (see Figs. 11 and 12) is composed of a fire-place A, the flame from which circulates in the coiled flue CC round the large crucible, or pot, of re-

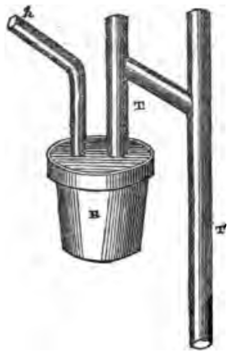
fractory clay B, placed vertically in the middle of the furnace. This crucible, closed at its upper end by the large refractory brick D well luted with clay, has three openings: a lower one, E, closed by a small brick kept in place by a screw, used for emptying the crucible; and two lateral openings—the lower one, *g*, by which the chloride enters, and the upper one, *h*, by which the resulting products escape.

FIG. 12.




The chlorine is furnished by the reaction of hydrochloric acid or peroxide of manganese, and is washed and dried, either by concentrated sulphuric acid, or by passing it over chloride of calcium—which, as we have stated, is obtained as an accessory product in the manufacture of alumina. We know that the reaction, at a high temperature, of chlorine on alumina mixed with carbon produces aluminous chloride, and the latter, finding in the mixture some soda chloride, seizes on this and thus yields an aluminous-soda chloride which escapes by the upper lateral opening *h*, to reach, and be condensed in, the receiver R (Fig. 13) placed outside the furnace. This receiver, which is of earthenware, and in the form of a flower-pot, is furnished with a cover through which the entrance tube *h* passes, as well as the double curved tube T T by which the excess of chlorine, and a little aluminous chloride lost, escapes to the chimney.

FIG. 13.




The operation terminated, the receiver R is found to be filled with a golden-yellow crystalline substance, which is the double chloride of aluminium and sodium. The furnace we have described nearly resembles that of M. Sainte-Claire Deville, except that in the latter the receiver was a small chamber arranged in the masonry; but it is evident that the present arrangement of a receiver, surrounded as it is on all sides by fresh air, renders the condensation more complete, —besides being itself more easily removed and replaced by another, than it would be to empty a chamber in the masonry, which also might cause a mixture of impurities with the product.

Another process has been proposed for getting this indispensable body—which consists of slowly evaporating to dryness the soda aluminate solution which we have seen yield the alumina, and then treating the residue of the evaporation with hydrochloric acid gas. But, besides the difficulty and the slowness of the dessication of the soda aluminate, it would be almost impossible to collect the product without some mixture of water which is formed at the same time, while the double chloride should be carefully guarded from humidity.

a little iron for pure double chloride is

## § II.

The manufacture of the sodium has been but little modified, and yet it is a point which has a great influence on the cost of producing the metal. The sodium is obtained by the reaction of carbon on the soda added to the calcic carbonate. The operation is effected in sheet-iron rivetted cylinders, in a small special furnace (see Figs. 14, 15), while formerly the cylinders were heated in the fire-place of a reverberatory furnace used for fusing the aluminium. It is unnecessary to point out that it is an improvement to render independent of each other any apparatus which should not be in operation at the same time, and which consequently, when not connected, would mutually interfere with each other.

FIG. 14.

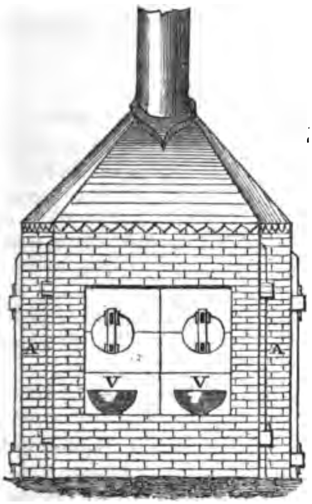
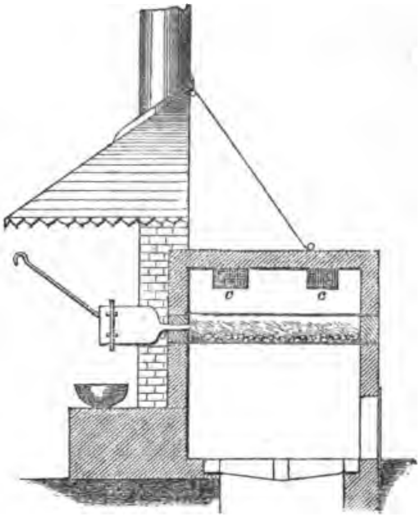
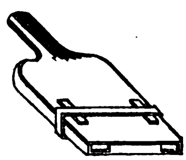


FIG. 15.



The materials employed are the salt of soda, small coal, and a beautiful very pure white limestone finely pulverised. The mixture is introduced into the two sheet-iron cylinders—the latter being placed horizontally in the furnace as shown in Fig. 15. The cylinders are closed by two cast-iron luted plugs, which extend to the outside of the furnace in order to be sufficiently cool. The anterior plug is bored with a hole through which the neck of the receiver is introduced—this receiver being the same as that proposed by MM. Donny and Mareska, and shown in the accompanying drawing, Fig. 16. It consists essentially of two cast-iron plates, one of which has a ledge or flange round the greater portion of its circumference—so that when the two are keyed together, as shown in the drawing, they leave a flat opening in which the sodium condenses.

FIG. 16.



The cylinders are supported by bricks which can be replaced for the charging, and are raised tolerably high above the fire-place; yet notwithstanding this precaution they wear out very quickly and have to be replaced after a few charges. Their dimensions are 4" in diameter and 30" long. The fire is lighted in the fire-place, and the flame, after acting on the retorts, passes off by the flues *c c* (Fig. **15**), and then down the side flues A A (Fig. 14), by which it escapes to the underground flue common to all the furnaces.

As soon as the distillation commences, a workman, by the assistance of an iron rod, runs off the sodium into the two little pans V V, which contain Schist oil; thus collecting it as it condenses. The oil, being placed very near the furnace, is maintained at a sufficient temperature to keep the sodium in a fluid state.

The scum which floats is remelted under the Schist oil, and yields a fresh quantity of sodium. It is then run off into small cakes of a truncated pyramidical form, each weighing about 7 ounces avoirdupois, which are kept in oil.

## § III.

The final reaction which yields the aluminium is effected in a reverberatory furnace in which the double chloride of aluminium and sodium is placed; to which is added a few cakes of sodium, calculated at 5 per kilogramme (2·2 lbs.), cut into two or three pieces —and lastly cryolite, which is the only flux fit to employ since it contains neither silica or iron. The composition of this ore, which corresponds to the formula $Al^2Fl^3,3NaFl$, is:—

| | |
|---|---|
| Fluorine .. .. .. .. .. | 54·5 |
| Aluminium.. .. .. .. .. | 13·0 |
| Sodium .. .. .. .. .. | 32·5 |
| | 100·0 |

This substance, which is produced from a large vein in Greenland, and which was formerly the only ore of aluminium, is at present only used as a flux; an immense advantage when we consider that cryolite only yielded 5 % of aluminium, and that its price, of recent years, was nearly 15*l.* per ton.

Care is taken, during the charging, that the fragments of sodium are covered by the other substances, and that the heating is progressive. The reaction soon commences, and that so violently that it rapidly raises the walls of the furnace to a red heat, and the matters soon become perfectly "liquified." In tapping, the scoria first runs off, and then the metallic aluminium which is perfectly fluid and forms in a single ingot weighing about 17½ lbs.

Formerly the metal was not made so perfectly liquid, and some portion remained, in the form of globules of greater or less size, disseminated in the mass. In all cases, a portion of the grey slag, which is last run off, is taken and pulverised, and then riddled to separate the globules, of which some always remain.

After this, the aluminium has only to be remelted in an earthenware crucible heated in a wind-furnace, and re-cast pure and ready for market.

[illegible]

It will be thus seen that the metallurgy of aluminium has made great strides in a short time, and at present has taken a regular business aspect, inasmuch as the ores operated on are more accessible, and are treated by apparatus with which all metallurgists are familiar, so that there is no uncertainty or doubt as to the result to be obtained. The only step that seems yet to be made to bring this metal, so valuable for many of its properties, abundantly into the market, is the total exclusion of cryolite—too dear and too rare an ore—and also a little more continuity and consequent economy in the operations.

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# Abstracts and Reviews.

## M. MOISSENET ON THE CORNISH METHODS OF DRAWING STUFF.

*De l'Extraction dans les Mines du Cornwall. Puits inclinés et coudés.* Par M. L. Moissenet, Ingénieur des Mines. Paris: Dunod, Quai des Augustins, No. 49.

(*Concluded from page* 157.)

### § 3. *Comparison and Discussion of the Various Methods Described.*

Average Velocity of Winding, and Out-Put of Shafts.—In order to institute a comparison between the various systems of winding, it is necessary, in the first place, to consider the quantity of stuff which is possible, under each system, to be drawn through a shaft. We have seen that by the system of filling adopted in Cornwall a limit is placed to this quantity, and that a shaft can scarcely put out more than 80 tons in twenty-four hours, or 24,000 tons in three hundred working days. Within this limit the daily out-put depends on the average lode of the skip or kibble, the depth, and the average rate of winding: the time occupied in filling, which is nearly constant, is, as we shall see, a matter of special consideration.

The use of kibbles limits the rate of winding to within a very moderate velocity; for, in inclined shafts, there is the danger of the kibble catching in projections of the rock or the timber, and the consequent breaking of the chain—a danger which exists to a certain extent, although in a less degree, in vertical shafts. In the case of either kind of shaft, however, the danger of the kibbles striking together in passing obliges a slackening of the speed about the period they are expected to meet — that is, at the period of the drawing, when a considerable velocity would be advisable.

Kibbles with chains in inclined shafts are wound at an average rate of 150′ per minute. At Dolcoath the velocity is 170′: and at Fowey Consols, in vertical shafts with flat ropes, it reaches 208′. Skips may without inconvenience be drawn with much greater rapidity—but one still inferior to that of the cages in the vertical shafts of collieries. In Cornwall, with flat ropes, the velocity rarely exceeds 305′ per minute; at Levant in 1858, with a wire rope, it attained 400′. Under each method, the time taken up in the movements required for filling and landing may be estimated at three minutes—either for a kibble of 6 or 7 cwts. with one filler, or for a skip, or from 11 to 14 cwts. with two fillers. At any rate, I shall advisedly neglect any slight variations in this time, and take it at three minutes, so as to facilitate a comparison of the various methods.

Representing by a formula the productive power of a shaft, let :—
$P$ = the weight drawn in 24 hours, or 1,440 minutes.
$p$ = the load of the kibble or skip.
$H$ = the depth drawn from.
$v$ = the average velocity per minute.
$c$ = time occupied in the stoppages and in filling, in minutes.
$a$ = time occupied in winding, in minutes.

Kibbles or skips will therefore succeed each other at intervals of $c + a$, or $c + \frac{D}{v}$ minutes: we have therefore

$$(\alpha)\ P = p \times \frac{1440}{c + a}, \text{ or } P = 1440\ \frac{p\,v}{c\,v + H}\ (\beta).$$

We shall discuss further on the special influence of the depth; but in the first will examine that of the velocity, or rate of winding with an equal load.

$P$ is never proportional to $v$, but it approaches it in proportion as the depth increases—that is to say, the value of the term $c\,v$ in the denominator diminishes in importance by the side of that of $H$.

If we consider the cases of a velocity of 164′ (with kibbles and chains), and of 328′ (with skips and flat ropes)—and assume the drawing to be successively from depths of 54½ fms. apart—and admitting for a moment that $p$ has an equal value throughout, and that $c = 3$—we arrive at the following result as to how the ratio in which the weight of stuff drawn from a shaft, from the several depths given, will be increased by doubling the velocity :—

| Depth drawn from. | With an Average Velocity of— 164 Feet. | 328 Feet. |
|---|---|---|
| 54½ fms. .. .. | The quantity drawn with | 125·0 |
| 109 " .. .. | this velocity from the re- | 140·0 |
| 163½ " .. .. | spective depths being taken | 150·0 |
| 218 " .. .. | = 100, the quantity drawn | 157·1 |
| 272½ " .. .. | at the double velocity will | 162·5 |
| 327 " .. .. | be that given in next column. | 166·6 |

So we see that in doubling the rate of drawing or velocity, we only increase the out-put by ¼ drawing from a depth of 54½ fms., and by ⅔ drawing from a depth of from 270 to 325 fms.; while it would be almost doubled, whatever the depth might be, if the filling were effected in an almost instantaneous manner, as in coal mines. Hence, under the Cornish system of drawing, an increase of velocity is not so efficacious as might seem at first sight; and if it were attempted to be abused, it would quickly bring about grave difficulties in keeping the apparatus in order.

The production of a shaft may also be increased by augmenting the load in the kibble or skip; but still the necessity of filling by hand-labour still prevents $P$ from increasing proportionally to $p$. The term $c$ (formula $\alpha$) is the sum of the two elements—the time lost at the surface, which is a constant quantity, and that occupied in filling, the length of which varies in direct proportion to $p$. Consequently, if with a kibble of 6 cwts. we suppose $c = 3$, with a kibble of 12 cwts. $c \angle 6$; and if we take $c = 6$, we shall prudently remain below the possible increase of the production.

It is on this hypothesis that I have constructed the following table.

In column A (which applies to kibbles) the actual quantity drawn is taken = 100; and for the purpose of comparison (it being assumed that

$p = 1$ and $c = 3$) is given the quantities to which this would be increased in drawing from the various depths given, ranging from $54\frac{1}{2}$ fms. to 327 fms. if the load were doubled ($p = 2$, $c = 6$), but the same velocity (164′) maintained. Column B applies similarly to skips; and lastly, in column C, a comparison is drawn between skips and kibbles—the former being assumed to have double the capacity, and to be drawn with double the velocity of the kibble, but requiring only an equal time for stoppage ($c = 3$).

POSSIBLE PRODUCTION, BY SKIPS AND KIBBLES, ACCORDING TO THE VELOCITY AND LOAD.

| Depth drawn from. | A. | | B. | | C. | |
|---|---|---|---|---|---|---|
| | With an Average Velocity of 164′ | | With an Average Velocity of 328′ | | $c = 164'$ | $v = 328'$ |
| | $p = 1$ $c = 3$ | $p = 2$ $c = 6$ | $p = 1$ $c = 3$ | $p = 2$ $c = 6$ | $p = 1$ $v = 3$ | $p = 2$ $c = 3$ |
| $54\frac{1}{2}$ fms. ... | Quantity drawn from respective depths being = 100, quantity drawn ($p = 2$ and $c = 6$) will be as in next column: | 125·0 | Quantity drawn from respective depths being = 100, quantity drawn ($p = 2$ and $c = 6$) will be as in next column: | 114·5 | Quantity drawn from respective depths at this velocity being = 100, quantity drawn with double velocity ($p = 2$ and $c = 3$) will be as in next column: | 250·0 |
| 109 „ ... | | 140·0 | | 125·0 | | 280·0 |
| $163\frac{1}{2}$ „ ... | | 150·0 | | 133·3 | | 300·0 |
| 218 „ ... | | 157·1 | | 140·0 | | 314·2 |
| $272\frac{1}{2}$ „ ... | | 162·5 | | 145·4 | | 325·0 |
| 327 „ ... | | 166·6 | | 150·0 | | 333·3 |

I shall just point out a few of the results shown by this table:—

1. If in a shaft a kibble of 5 or 6 cwts. is replaced by one of from 10 to 12 cwts.—still maintaining one filler per shift and a velocity of 164′—the production will be increased by from $\frac{1}{2}$ to $\frac{2}{3}$, according as the depth drawn from is 165 fms., or from 270 to 325 fms.

2. If for a skip of from 10 to 12 cwts. one of from 20 to 24 cwts. is substituted—employing two fillers per shift and drawing with a velocity of 328′—the increase will be from $\frac{1}{3}$ to $\frac{1}{2}$, according as the depths are 165 fms. or from 270 to 325 fms.

3. If in a shaft a 5 or 6 cwts. kibble is replaced by a skip of from 10 to 12 cwts., it is possible, for depths varying from 160 fms. to 325 fms., *to increase the production three-fold.*

It must not be forgotten that these results are based on the assumption of the following values:—$c = 3$, $c = 6$, $v = 50$, $v = 100$, which of course are by no means absolute, and which have only been selected in order to show the sense of the possible variations of drawing; which, it may be well to repeat, is up to the present time limited by the mode of filling. At present, in an inclined and elbowed shaft, about 10,000 tons are drawn from a depth of from 200 to 270 fms. by kibbles and chains in a year of three hundred working days. The introduction of skips in such a shaft would, according to column C, increase thus to 32,000 tons; but this theoretical figure could not be attained by the fillers, and the ordinary performance of six fillers in three shifts would reduce this maximum to about 24,000 tons. This production, however, would correspond to a weight of ore and deads representing extensive workings by a considerable number of miners—as extensive as are usually found within reach of a single shaft.

*Comparative Advantages of Skips and Kibbles.*—The leading characteristic of drawing by skips, and probably its most important advantage, is the increased power of production which it gives to a shaft. I have already pointed out most of the other considerations which would lead us to prefer skips to kibbles, but it may be well again to give a summary of them.

1. Increased security for the skips themselves compared with kibbles, for the timbering of the shaft, and for the fillers.

Breakages are less frequent even when chain is used, for, being guided, sudden shocks are avoided, which is the ordinary source of these accidents. If the chain breaks the skip is knocked to pieces at the bottom of the shaft, but with little other damage than its loss; while the falling away of a kibble may cause extensive damage in a timbered shaft. The skip also allows of a safety catch apparatus being used—an apparatus less efficacious, it is true, in practice than in theory, and which, if kept in bad repair, may even be a source of danger by inspiring undue confidence.

While the kibble is being drawn up, loose stones, detached from the walls of the shaft, or falling out of the kibble itself, literally rain in the shaft, to the great danger of the filler, and even of the miners and agents travelling through it—a danger which is almost done away with by the employment of skips.

2. An increase of duty by allowing the substitution of ropes for chains.

The use of a skip allows of the employment of flat hemp ropes in inclined and elbowed shafts; so, if the cages are constructed in such a manner as to compensate a fair proportion of the dead weight, the effective power of the motive engine may be found to be notably increased. The skips being guided also aids in this respect—both diminishing to some extent the friction, and avoiding the necessity of slackening speed where they cross.

As to round wire ropes, which cannot be used for kibbles, I have pointed out the circumstances under which they may be advantageously adopted. Very deep shafts, with considerable elbows, have led to the use of ropes of a great diameter, and large cylindrical drums—which are conditions essentially unfavourable for their adoption.

3. A diminution in the cost of labour. The expense of filling being the same, that of landing may be considerably reduced—and the same cost for engine-men is set against a larger production.

As in the case of every improvement, skips, however, entail certain inconveniences; the enumeration of which is equivalent to stating the advantages of kibbles.

1. First cost of fixing. Under this head we have almost always in the first place to consider the putting of the shaft in good condition—its enlargement, cutting down, and new timbering.

The cost of the guides, rails, &c., even of the largest size, is not considerable; a portion of the expense under this head is also balanced by the reduction of the cost of repairs, which will be rapidly covered if the inclined and elbowed shaft passes through heavy ground requiring conderable timbering.

2. An increase in the dead weight. Up to the present time the skip weighs 70°/。 of its load, and the kibble 50°/。 only. This addition to the weight does not sensibly affect the engine, but it tells in the wear of the chain or rope.

3. The inducement it gives to the adoption of engines of exaggerated power, which thus gives rise to frequent idleness.

On this point the characteristic advantages of skips turn against them. Indeed, discontinuity in drawing is an abundant source of expense by causing a wasteful employment of coal and of labour; and, if a shaft is never required to draw more than 8,000 or 10,000 tons a-year, a continuous working by kibbles is more economical than working by skips eight hours out of the twenty-four, or two days a week. This statement is easily proved.

On comparing two mines where the drawing is permanent—Dolcoath and United Mines—we have found that the cost per ton drawn was about the same under the two systems. This fact of the equality of cost has been

proved elsewhere than in Cornwall. At Grand-Hornu Mine the quantities annually drawn from a depth of 194 fms. (355 metres) by shafts No. 8 and No. 12—which may be considered as vertical—were respectively 100,000 and 200,000 tons. M. Glépin, in his memoir on this subject, estimates the total annual saving resulting from the substitution of guided cages for tubs (capable of drawing an equal quantity) at 2,718*l*. (67,956 frs.) for shaft No. 8, and 5,397*l*. (134,940 frs.) for shaft No. 12.

But in these figures there is included respectively 2,500*l*. (62,524 frs.) and 5,000*l*. (125,047 frs.) for the increased value of the coal, in consequence of its being less broken. Deducting these items of increased value, which are of no account in metallic minerals, there remain 217*l*. (5,432 frs.) and 395*l*. (9,892 frs.)—or an approximate saving per ton of 0·054 and 0·049 frs. (about ½*d*.), which becomes almost negative if we take into account the first cost of putting in.

We thus understand that, if skips are adopted under such conditions as to remain idle a considerable portion of the time, the cost per ton will be really greater than by the comparatively rude system of kibbles and chains, working continuously. Without well-founded prospects, therefore, showing, as in the case of a colliery, something to be calculated on for many years steady working, it is imprudent, in metallic mines, to exaggerate the means of action; for an excess in this respect may bring about the ruin of an enterprise, as much as an insufficiency would have done.

*The most advantageous System of Drawing: Improvements in Details.*—At the commencement of this memoir, I stated that the object was not to look for the establishment of any typical method—any absolute perfection. Still, leaving out of the question the opposite conditions of a vertical shaft and of an inclined plane—and also the case of a shaft whose inclination changes completely—and confining ourselves to the more frequent case of inclined and elbowed shafts, partially vertical and partially with an underlie in the same direction, not exceeding 20° or 30° from the vertical, it is possible, from the preceding facts, to draw certain general conclusions. I give these under the form of a succinct description of a combination of the best arrangements, according to my ideas, at present adopted in Cornwall—adding only some suggestions for improvents in details.

CONDITIONS.—An inclined and elbowed shaft, drawing annually from 18,000 to 24,000 tons from a depth of from 160 to 270 fms.

SYSTEM.—Skips and flat hemp ropes; worked by a 26" cylinder engine, vertical, double-acting, condensing, 7′ stroke, connected by a 3′ 6″ crank.

Arrangements in shaft—bearings 35′ apart, sheaves 8′ diameter; guide-rails in the form of ⊥, fixed to pieces stretching from wall to wall, arranged so as to leave a free space under and between the two rails. Cast-iron friction cylinders, working freely, fixed near the foot-wall of the shaft, 10 fms. apart, one set for each skip-road, to keep up the rope and prevent its rubbing against the wall.

Steel skip, weighing complete 6 cwts., which will easily carry an average load of 13 cwts. If the size of the shaft prevents the guides being placed sufficiently far apart, the skip may be made deeper, for the use of rails dispenses with vertical friction-bars, and consequently the back of the skip may, without inconvenience, extend beyond the face of the guides.

The flat-rope to be 5″ for shallow depths, and 5″ and 6″ combined for the greater depths. If the engine is some distance from the shaft, a ⅝" chain may be attached, of such a length that, the skip being at the surface, the chain may not reach the cage.

Between the skip and its connection, it would be well to place a spring, as in collieries, to break the impact. The diameter of the centre of the cage should be calculated so as to establish a compensation for a depth some fathoms greater than the average depth drawn from at the date of

erection. After a few years, when this depth increases, this may be modified as required to get a good compensation.

Several advantages will be gained by these arrangements and precautions:—an increase of duty; less wear and tear of the guides; and a preservation of the ropes, by the adoption of the friction cylinders, and the possibility of diminishing the speed (for a like production) by augmenting the useful load of the skip. With a careful attention to the state of the ropes, breakages will be rare; and without having recourse to safety-catch arrangements, the steel skip, notwithstanding its original cost, will last sufficiently long to be an economy in itself.

As to labour, no improvement seems possible in this respect—except, perhaps, in the rare case where the soft and friable nature of the ore broken allows of hoppers with traps being employed for filling the skips.

*Influence of Depth:* 1. *On the Cost of Drawing.*—At first sight it seems evident, and has been so stated, that the cost of drawing a ton increases, by any given method, more than proportionally to the depth; in other words, that the cost of a ton raised 100 metres, or $T^{100}$, is larger in deep mines. Let us examine in what sense the elements of this cost vary:—

The wear and tear of skips or kibbles, and the maintenance of the shafts, may be considered as proportional.

The consumption of chain or rope, in consequence of the excess of load under which they work, or their greater transverse dimensions—and that of the coal, and other materials for the engine, in consequence of the increased want of compensation for the dead weight—are more than proportional; but the labour, both at the engine and in filling and landing, is less than proportional; indeed, the average rate of drawing, and the time consumed in filling, being supposed the same as for a lesser depth, the period of drawing is longer, and in a given time more of $T^{100}$ is executed.

For example: let us take $v = 50$ metres, $c = 3$; let us suppose $p = 1$ ton, and that the drawing is from two levels, $H = 450$ metres (245 fms.) and $h = 150$ metres (82 fms.).

It will be readily seen that, during each period of 12 minutes, there will have been produced—at the depth H, 4·5 $T^{100}$, and at the depth of $h$, only $2 \times 1{\cdot}5$ or 3 $T^{100}$. If the velocity was 100 metres, the respective values of $T^{100}$ would be 4·5 and 2·5, for an interval of 7½ minutes: that is to say, the depth being increased from 150 to 450 metres, in the ratio of 1 to 3, the cost of labour of $T^{100}$ is reduced from 3 to 2, or from 9 to 5, according to the velocities. These figures are far from being exaggerated, for they suppose $c$ to be constant; but if, after a rest of 9 minutes, the fillers load the skip in 3 minutes, we cannot calculate upon its being loaded as rapidly after a rest of only 3 minutes. The diminution of the cost of labour, of $T^{100}$, will therefore be practically greater than has been indicated in the preceding calculations.*

On the other hand, the cost of labour seems, up to the present time, to have been from 30°/₀ to 40°/₀ of the total—so, that, within certain limits, it may be stated, that the influence of depth on the cost of $T^{100}$ may be sometimes unfavourable, and sometimes favourable; that is to say, is, on an average, nearly negative; which may be thus expressed—that the cost of drawing a ton of ore is, within certain limits, in direct proportion to the depth.

It will be interesting to state a sufficient number of examples to make this fact obvious; I, therefore, give the following values (without discussing them) of $T^{100}$, deduced from the facts I have given:—

* Compare the last column but one of the table *ante* page 156, on this subject.

| | | d. | | | d. |
|---|---|---|---|---|---|
| Dolcoath .. | 1855.. | .. 4·92 | Carnbrea .. | 1857 | .. 6·72 |
| | 1861.. | .. 3·36 | | 1860 | .. 5·28 |
| United Mines, | 1855.. | .. 4·2 | South Frances, | 1861 | .. 3·74 |
| Levant .. | 1861.. | .. 3·84 | In the two latter mines, cost of maintenance of shaft is not included. | | |

2. *On the Production of a Shaft.*—The formula given above furnishes us, by a slight modification, with the measure of influence which the depth has upon the production.

Supposing N be the number of skips or kibbles landed by a continuous working of 24 hours, we have:—

$$N = \frac{1440}{c + a} \text{ or } N = \frac{1440}{c + \frac{H}{v}}.$$

When we work out this for the velocities of 164′ (kibbles) or 328′ (skips), putting $c = 3$, we get results nearly approximating to the practice of Cornwall:—

| Depth drawn from. | No. of Kibbles & Skips drawn in 24 hours. | |
|---|---|---|
| | $v = 164'$ | $v = 328'$ |
| 163 fms. .. | 160 | 260 |
| 218 " .. | 131 | 206 |
| 273 " .. | 111 | 180 |
| 327 " .. | 96 | 160 |

These figures show the following results:—

If, with an increased depth, the velocity and the load are kept the same, the production—which is taken as $=100$ for the depth of 163 fms.—is reduced to about 80, 70, and 60, for the depths of 218 fms., 273 fms., and 327 fms., respectively.

If, for the depth of 327 fms., skips are substituted for kibbles, the production *may* be more than trebled, and will be brought up to double what it was at 163 fms. with kibbles.

In proportion as the depth of a working increases, in the same proportion does the utility of skips become developed by a diminution of the probabilities of stoppage. In the first place, if we even merely content ourselves with maintaining the production, the simple increase in the journey of the skips or kibbles absorbs a portion of the drawing power—but, we are almost necessarily led to an increased production. In fact, with the increase of depth there follows that of a great number of other expenses—that of the water charge, that of keeping the shafts and workings in repair, that of the labour of the miner by the greater difficulty of getting to the workings, and that even of drawing as we now see. With these it, of course, becomes necessary to increase the production, particularly when we add to them certain other disadvantageous circumstances;—such as the reduced produce of the work raised, caused by the ore, although being still abundant, being more disseminated in the gangue;—and that of the rock becoming very costly to break in consequence, partly of its increased hardness, and partly on account of the increase of temperature and more imperfect ventilation. These circumstances are not unknown in the mines of Cornwall; and we see that the question of drawing—a secondary one for many shallow workings—may become an extremely grave one in the probable case of large wants and great depths combined. Ample power, combined with economical arrangements, are the essential conditions to be sought for in any method to be adopted.

It remains for me only to add a few concluding observations on the systems of drawing at present in operation; this, I shall do without reserve, and subject to the correction of any misconceptions I may have made:—

*The Importance of the Subject of Drawing in Cornwall and Devon.*—Let us see what is the average depth drawn from in the two counties—the weight of the principal ores drawn each year, and the total expense at which it is effected.

Among the deepest mines actually or recently at work are:—Fowey Consols, to the east of St. Austell; the United mines recently joined to their neighbour, under the name of Clifford Amalgamated—Dolcoath, with Cook's Kitchen and Tincroft on the east, Stray Park and Camborne Vean on the west, and North Roskear on the north—all in the centre of Cornwall; then towards the south and west, the old Wheal Vor mine, and the Alfred mines near Hayle, which having been reworked some ten years ago, have been recently abandoned after enormous loss; further, at the extremity of the peninsula, Botallack and Levant, which extend under the ocean; and lastly, in Devonshire, the old and long prosperous mine of Wheal Friendship. Some of these exceed the depth of 325 fms., and the others, that of 250 fms. A large number of very productive mines exceed 200 fms. in depth.

The depth of the sump shaft, however, does not represent the average depth of the drawing. This latter depth, for the average of the two counties, may vary from year to year, by the resumption or abandonment of very extensive and very deep old mines, or by the often very rapid development of new and shallow workings. It may, however, be approximately determined at any given time by ascertaining the circumstances in the principal districts.

The following are some of the leading facts that have come under my observation:—

At Devon Great Consols, about 120,000 tons a-year are drawn from ten shafts (Richards' shaft at Wheal Anna Maria was not altogether 200 fms. deep in 1858); at Carn Brea, near Redruth, nearly 50,000 tons were drawn by a dozen shafts from the depth of 150 fms.; at Dolcoath, from 43,000 to 44,000 tons from a depth of 260 fms.; at Fowey Consols 36,000 tons from a depth of 240 fms.

The deep mines of the centre and the west are counterbalanced by others equally productive in the same localities—by those of the Caradon district near Liskeard, and by those of Devonshire; but if we take into account that the depths are calculated from the adits, and that these adits are at an average depth of 30 or 40 fms. from the surface, I think that we may take 180 fms. from grass as the average depth at the present day.

As to the total weight of stuff drawn, we shall be below the truth in taking it, for each ton of clean ore ready for sale, at:—

| | | | | |
|---|---|---|---|---|
| 50 | tons of stuff | per ton of | clean ore in | tin mines. |
| 3 | " | " | " | copper mines. |
| 12 | " | " | " | lead " |

I leave out of the question iron mines and those of other metals.

Combining these facts with those given in the *Mineral Statistics* for 1859, we arrive at the following conclusions for the two counties:—

| | Clean Ore sold in 1859. | Presumed Proportionate Quantity of Stuff drawn. |
|---|---|---|
| | Tons. | Tons. |
| Tin .. .. .. | 10,670 | 540,000 |
| Copper .. .. | 181,848 | 550,000 |
| Lead .. .. .. | 11,015 | 130,000 |
| Total quantity drawn .. .. | | 1,220,000 |

a quantity greater than a sixth of the total coal production of France.

Assuming the average cost per ton raised 100 fms. to be 7·9*d.*—this × 1·8 (for the assumed average depth of 180 fms.) will give 14·22*d.* The cost for drawing being thus about 14¼*d.* per ton (without taking into consideration general expenses), the total annual cost for drawing in Cornwall amounts at least to 73,500*l.*—and probably to 80,000*l.*, all expenses included.

The cost of drawing calculated per ton of clean ore ready for sale will be—

| | |
|---|---|
| 60*s.* per ton of black tin, worth per ton about .. | £75 |
| 3*s.* 7*d.* per ton of copper ore of 6¼°/ₒ produce, about | 6 |

which represents, respectively, 4°/ₒ and 3°/ₒ of the market value of the product.

Although this does not seem in itself very high, yet, being given at its lowest, it must be expected to increase in proportion as the workings increase in depth—and even at present it is far from being an item to be neglected. It furnishes, at the same time, an excuse for the relative imperfection of the systems of drawing at present in use, and a sufficient motive for the interest which should be felt in their improvement. It is the duty of the deep and productive mines, among the first, to give their attention to these improvements.

## ABSTRACTS FROM BRITISH ASSOCIATION PAPERS.

### On a Deposit in Blast-Furnaces.
### By J. Pattinson.

A substance in fine powder, varying in colour from blackish-grey to almost white, is deposited in the large tubes used for conveying the waste gases of iron-smelting furnaces to the boiler and heating stoves, where they are economised. Some of the constituents of this deposit are doubtless volatilised by the intense heat of the furnaces, whilst others are merely carried over mechanically by the intense heat of the gases. In the waste gas tubes of the furnaces in which Cleveland ironstone is smelted this deposit accumulates in such quantity as to necessitate the cleaning out of the tubes every three or four months. It also adheres to the bottom of the boiler, and to the heating-stove pipes, from which it has to be occasionally removed, as it materially prevents the conduction of heat. Samples selected for analysis were obtained from the waste gas tube of a furnace belonging to Messrs. Gilkes, Wilson, Pease, and Co., of Middlesbro'. In order to avoid as much as possible the presence of particles of dust carried over mechanically, the sample was taken from the under side of the tube at a point distant about 140 feet from the furnace. A mixture of Upleathan and Rosedale ironstone, with Weardale blue ironstone and South Durham cokes had been smelted in the furnace for some considerable time previous. The deposit was of a dark grey colour, and was in impalpably fine powder. On analysis it was found to contain—protoxide of iron, 14·22; oxide of zinc, 10·48; sulphide of zinc, 13·70; alumina, 8·20; lime, 12·32; magnesia, 5·03; chloride of sodium, 4·74; ammonia, 0·70; thallium, trace; sulphuric acid, 3·18; free sulphur, 0·17; silica, 22·60; carbonaceous matter, 4·50 = 99·84. The portion soluble in water had a slightly acid reaction, probably owing to sulphate of zinc, which was found to be present to the extent of 0·66 °/ₒ. It also contained sulphate of lime, sulphate of ammonia, and chloride of sodium. A very small portion of the alumina and silica are dissolved by boiling with a solution of potash, from which fact, together with the acid reaction of the portion soluble in water, it is inferred that the most of the alumina, lime, and magnesia are in chemical combination with the silica. Sulphuretted hydrogen is copiously dissolved on the addition of hydrochloric acid, but not at all on the addition of hot acetic

acid, and about 10 °/₀ of oxide of zinc is dissolved by caustic potash. It is, therefore, concluded that the sulphide present is sulphide of zinc. The source of the zinc is, doubtless, the ironstone, as small pieces of zinc (blende) are occasionally found in the mines, and its presence in minute quantity was detected diffused throughout the mass of ironstone. Thallium was detected by means of the spectroscope. A portion of the deposit held on a platina wire in the flame of a Bunsen burner gave faint but unmistakeable indications of the presence of this metal.

### On Zinc, Nickel, and Cobalt in Cleveland Ironstone.
### By J. Pattinson.

The deposition of considerable quantities of oxide of zinc in the tubes conveying the waste gases from the blast-furnaces in which the ironstone was smelted had long indicated that it contained zinc, although none of the published analyses of that stone mentioned the presence of that metal. The experiments which were made were conducted with a view to ascertain whether the zinc was distributed uniformly throughont the mass of the deposit, or if it only occurred occasionally, filling up small crevices. From 4 ozs. of the stone a quantity of zinc was obtained equal to ·32 of a grain per lb. of ironstone, or about 10 grs. to the ton. At the same time, indications were obtained of the presence of nickel and cobalt, and a subsequent quantitative analysis showed that the ironstone contained ·72 of a grain of nickel and ·12 of a grain of cobalt per lb. The amount of these two metals in pig-iron, malleable iron, and puddling-furnace cinder, all of which were produced from Cleveland ironstone, had been estimated without any admixture of the ores. They all contained quantities of nickel and cobalt, varying in the case of the former metal from ·0045 to ·027 °/₀, and in the case of the latter from ·0009 to ·003 °/₀. An admixture of nickel with iron was said to improve the quality of the latter, but it was scarcely probable that either nickel or cobalt in the preceding proportion would affect the quality of the iron appreciably.

### Report on the Chemical Nature of Alloys.
### By Dr. Matthiessen.

Dr. Matthiessen remarks that our knowledge of this subject is at present very limited, and so far as can be ascertained a liquid alloy of two metals may be either (1) a solution of one metal in another, or (2) a chemical combination, or (3) a mechanical mixture, or (4) a solution or mixture of two or all of the above. On the contrary, an alloy in the solid state may be either (1) a solidified solution of the one metal or the other, or (2) a chemical combination, or (3) a mechanical mixture, or (4) a homogeneous diffusion or mechanical mixture of two or all of the above. But how are we to find out what an alloy was?—chemistry can only afford us the means. By analysis, it was not enough to determine the chemical nature of alloys; the study of their physical properties offered additional means by which the nature of an alloy might be ascertained, and these physical properties might be divided into two classes:—1. Those which do not indicate the chemical nature of the alloy; and 2, those which do indicate the chemical nature of the alloy. The number of alloys experimented with was upwards of 250, and they were all made of purified metals, and the conducting power determined with a modification of Wheatstone's balance, arranged by Kirchoff, under whose directions the first results were obtained. The conclusion drawn from the research on the electric conducting power of alloys was that they might be divided into two classes:—1. Those metals (lead, tin, zinc, and cadmium) which, when alloyed with each other, conducted electricity in the ratio of their relative volumes.—2. Those metals (bismuth, antimony, platinum, palladium, iron, aluminium, gold, copper, silver, and probably most of the other metals) which, when alloyed with one

another, or with one of those belonging to the first class, did not conduct electricity in the ratio of their relative volumes, but always in a lower degree than that calculated from the mean of their volumes. He had found that the first group of alloys was solidified solutions, and neither mechanical mixtures (with the exception of lead-zinc alloys) nor chemical combinations.

### On the various kinds of Pyrites used on the Tyne and Neighbourhood, in the Manufacture of Sulphuric Acid.

By J. Pattinson.

Iron pyrites, or sulphate of iron, has been used on the Tyne, Mr. Pattinson says, as a source of sulphur in the manufacture of sulphuric acid, which is concentrated and sold for special purposes, for which the acid from pyrites is unfitted, owing to its containing a small quantity of arsenic; whilst about 75,000 tons of pyrites are annually consumed, containing on an average 34,000 tons of sulphur, and representing a value of about 110,000*l*. Cleveland pyrites is found between the beds of ironstone of the Cleveland district, and is only used at one large sulphuric-acid manufactory at Middlesbro'. The deposit varies from 6″ to 12″ in thickness, and consists of concretions of oolitic particles of pyrites, mixed with ironstone, which crumble to pieces on exposure to the air. On an average, it only contains about 25 °/₀ of sulphur. Of the "coal brasses" variety, from 6,000 to 8,000 tons are used on the Tyne per annum. It is found in the collieries of the district, associated with the coal, and, besides iron pyrites and coal, often contains variable quantities of carbonate of lime and oxide of iron. What the future of the pyrites trade may be it is impossible to foresee, but this mineral exists in such inexhaustible abundance, that its use in the manufacture of sulphuric acid is not likely to be superseded by sulphur, unless new and cheaper sources of the latter are discovered.

Mr. Spence stated the fact that at the present moment in Swansea, as much sulphur was being thrown off in the form of sulphurous acid gas as would make all the sulphurous acid gas used in our immense chemical manufactories. His own calculation was that they were throwing into the atmosphere there a quantity equivalent to about 4,500 tons of sulphuric acid per week. Hitherto it had been impossible to use that in the manufacture of sulphuric acid. At least, there was no plan that had been generally adopted that could be made useful. He, however, had recently devised a furnace by which he was using pyrites, and if it were adopted by the Swansea smelters, they could manufacture all the sulphuric acid almost without any cost.

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## ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

The annual meeting of this Society was held at Penzance on Tuesday, September 22nd, Mr. Augustus Smith, M.P., President, in the chair. Mr. Smith commenced the proceedings by a long address, in which he referred to the Darwinian theory of development, to the portion of Sir William Armstrong's address at the British Association Meeting relating to the exhaustion of our coal-fields, and to the deaths of Mr. John Taylor, and of the late Secretary of the Society, Mr. R. Q. Couch, concluding with some remarks on the "never-ending and ever complicated question—as it has unfortunately turned out—respecting the new buildings."

The only papers read were "Observations on the Caradon Mining District," contributed by Mr. W. J. Henwood, F.R.S., read by Mr. D. Davey, M.P., and "The Copper Mines of Corocoro, Bolivia," contributed and read by Mr. M. Punnett.

The first-named paper is offered by the writer as an appendix to his

communication "On the Metalliferous deposits of Cornwall and Devon," contained in the Society's fifth volume of Transactions. It describes in great detail the boundaries, composition, and structure of the granite and slate formations; the range and general character of the elvan-courses; the directions, inclinations, widths, and compositions of the lodes and cross-courses; and the results of their intersections; as well as the natures and positions of the rocks which form their opposite (walls) sides; and is illustrated by many plans, sketches, and tables.

Mr. Punnett stated in his paper that during the last five years 20,000 tons of copper barrilla, that is, metallic copper in a granular form, have been exported from the mines of Corocoro. The geological formation in which this copper is found, consists of beds of marls, sandstones, and conglomerates intercalated with beds of gypsum. The sandstones are impregnated with grains of metallic copper, and in the same formation native copper is found in plates, in denoritic forms and in some cases perfectly crystallised. There occur also in the neighbourhood arseniates of copper and other mineralised forms of that metal, not sufficiently rich to export in their raw condition, and which have not as yet been worked, from the scarcity of fuel.

After the report from the Council on the New Buildings had been read, the meeting proceeded to the election of officers for the ensuing year, when the following were elected on the nomination of the Council: Vice-Presidents:—Messrs. J. M. Williams, W. Coulson, D. P. Le Grice, and the Rev. M. N. Peters.

For the Council:—Messrs. Edward Bolitho, R. Davey, M.P., W. Richards, S. Higgs, C. D. Bevan, J. St. Aubyn, M.P., S. Borlase, Alfred Fox, — Boyns, F. Boase, G. Ross-Carne, and Walter Borlase. On the suggestion of Mr. T. S. Bolitho, the election of a secretary was left in the hands of the Council.

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## THE PRODUCTION OF CAST-STEEL DIRECTLY FROM PIG-IRON.*

None of the foreign papers seem to have noticed the attempts of Cazanave to obtain cast-steel directly from pig-iron. The idea itself appears to be very ingenious, but of course the question is whether it is applicable in practice. The foundation of this new method is the influence of steam on a thin stream of pig-iron. If we take an iron tube of a certain diameter with sides of the necessary strength, form a ring out of it, and fix on its circumference, towards the centre, three or more tubes, we have a tube ring with three or more radii. The radius is made fast to the tubular pipe; the ends of these tubes, which are open, do not quite reach to the centre of the ring, and have, therefore, between the ends an empty space, in which the pig-iron is allowed to flow in a stream of a certain strength. The steam let into the boiler from the tubular pipe flows out of the openings of the three tubes, and operates directly upon the pig-iron. It is said that the oxygen of the steam oxidises the carbon of the pig-iron, the silicium, a portion of the sulphur, phosphorus, and other impurities in the pig-iron; the hydrogen combines with the carbon, sulphur, phosphorus, arsenic, and other bodies, with which it forms combinations of hydrogen. The carbonised and purified metal falls into the crucible or other vessel placed immediately under the apparatus. The metal obtained contains impurities, and must therefore be smelted in crucibles in a blast or reverberatory furnace. This is the essential part of the process: the simplicity of the method and the cheapness of the product are evident.

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* Translated from the Russian *Gornij Journal* of E. Vysoky into the *Oesterr. Berg- und Hütten. Zeit.*

Now arise the questions :—is it possible to obtain steel in large quantities by this method; will it be of the same quality as the small quantity obtained on trial; and, if it is possible, at what price can it be obtained?

In answer to these questions Cazanave asserts that by his method steel can be obtained in great quantities, not inferior to the best steel, and proportionately cheaper; for his best quality steel can be obtained for 18*l*. per ton. This is difficult to believe but the inventor affirms that it is so, and at the same time warrants the excellent quality of his steel. In the present method of obtaining steel, good iron must be used which is cemented, and the cemented iron, that is the steel, is smelted in crucibles. By Cazanave's method cementation of the iron is avoided, so that the cast-steel may be obtained in unlimited quantities. If this new method turns out practicable, it will be possible to work up the whole daily production of a blast-furnace into steel. For this only the apparatus is required, which is not very costly, and which would be erected near the blast-furnace and stream of pig-iron. The stream would be divided into rays of the necessary strength and each one directed into an apparatus. By Bessemer's process about 10 tons of steel are obtained per day at Sheffield, while by Cazanave's method between 60 and 70 tons per day could be obtained, and a blast-furnace is being erected at Charleroi which will produce about 74 tons per day. The samples of steel furnished by this new process are reported to be very good. They were obtained from pig-iron smelted with coke, but it is supposed that charcoal pig-iron would give better results.

## THE BOARD OF TRADE RETURNS.

The "Accounts relating to Trade and Navigation of the United Kingdom, for the month ended 30th September, 1863, and nine months ended 30th September, 1863," have been issued by the Statistical Department, Board of Trade.

IMPORTS.—The quantities and relative increase and decrease of the imports of metals, metallic ores, and mineral products, for the month and nine months ended 30th September, have been as follows :—

| | Month ended 30th September. | | | Nine Months ended 30th September. | | |
|---|---|---|---|---|---|---|
| | 1862. | 1863. | Increase (+) or Decrease (—). | 1862. | 1863. | Increase (+) or Decrease (—). |
| Brimstone ... ... cwt. | 92,519 | 94,208 | + 1,689 | 844,435 | 587,293 | —257,142 |
| Copper Ore ... ... tons | 6,473 | 6,010 | — 463 | 63,885 | 58,689 | — 5,196 |
| Copper Regulus ... ... „ | 570 | 2,117 | + 1,547 | 25,802 | 14,584 | — 11,218 |
| Copper, unwrought and part wrought ... cwt. | 30,080 | 21,500 | — 8,580 | 206,380 | 178,580 | — 27,800 |
| Iron, in Bars, unwrought tons | 8,769 | 5,487 | — 3,282 | 27,759 | 28,765 | + 1,006 |
| Steel, unwrought ... „ | 406 | 271 | — 135 | 3,186 | 1,752 | — 1,434 |
| Lead, Pig and Sheet ... „ | 1,606 | 1,521 | — 85 | 15,308 | 18,677 | + 3,369 |
| Spelter or Zinc ... ... „ | 2,525 | 3,463 | + 938 | 12,516 | 21,133 | + 8,617 |
| Tin, in Blocks, Ingots, Bars, or Slabs ... cwt. | 8,977 | 4,372 | — 4,605 | 58,273 | 34,691 | — 58,273 |
| Silver Ore... ... value in £ | 22,095 | 11,910 | — 10,185 | 218,788 | 190,381 | — 28,407 |
| Petroleum ... ...tuns | 345 | 3,218 | + 2,873 | 13,074 | 29,876 | + 16,802 |
| Quicksilver ... ... lbs. | 306,884 | 589,621 | +282,737 | 432,138 | 1,152,733 | +720,595 |

EXPORTS.—The quantities, declared value, and relative increase and decrease of the exports of metals, minerals, and metallurgical articles of British and Irish produce and manufactures, for the month and nine months ended 30th September, have been as follows :—

| | QUANTITIES. | | | | DECLARED VALUE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Month ended 30th September. | | Nine Months ended 30th September. | | Month ended 30th September. | | | Nine Months ended 30th September. | | |
| | 1862. | 1863. | 1862. | 1863. | 1862. | 1863. | Increase (+) or Decrease (−) | 1862. | 1863. | Increase (+) or Decrease (−) |
| | | | | | £ | £ | £ | £ | £ | £ |
| Alkali: Soda ... ... ... cwt. | 227,304 | 191,785 | 1,610,935 | 1,608,193 | 98,890 | 77,224 | − 21,666 | 682,249 | 666,393 | − 15,856 |
| Coal, Cinders, and Culm ... ... tons | 910,049 | 794,195 | 6,453,923 | 6,239,329 | 403,235 | 357,853 | − 45,382 | 2,892,385 | 2,767,875 | − 124,510 |
| Iron, Pig and Puddled ... ... " | 46,318 | 53,596 | 353,151 | 365,901 | 127,996 | 144,555 | + 16,559 | 948,356 | 994,997 | + 46,641 |
| Iron, Bar, Angle, Bolt, and Rod... " | 28,939 | 30,514 | 227,294 | 245,066 | 225,202 | 236,943 | + 11,741 | 1,657,381 | 1,838,668 | + 181,287 |
| Iron, Railroad, of all sorts ... " | 38,615 | 42,376 | 309,947 | 363,607 | 243,966 | 314,940 | + 70,974 | 2,133,607 | 2,561,069 | + 427,462 |
| Iron, Cast ... ... ... ... " | 5,895 | 5,475 | 48,196 | 64,213 | 54,044 | 52,717 | − 1,327 | 419,738 | 542,251 | + 122,513 |
| Iron Hoops, Sheets, and Boiler Plates ... ... ... " | 11,027 | 11,272 | 76,862 | 100,929 | 105,270 | 146,747 | + 41,477 | 759,451 | 1,179,876 | + 420,425 |
| Iron, wrought, of all sorts ... " | 12,120 | 9,254 | 77,896 | 81,055 | 238,478 | 179,550 | − 58,928 | 1,519,005 | 1,557,762 | + 38,757 |
| Iron, old, for re-manufacture ... " | 2,260 | 369 | 18,340 | 11,779 | 8,724 | 1,485 | − 7,239 | 71,120 | 44,105 | − 27,015 |
| Iron Steel, unwrought ... ... " | 2,010 | 2,458 | 20,105 | 20,403 | 62,844 | 75,684 | + 12,840 | 650,504 | 657,412 | + 6,908 |
| Copper, unwrought, in Ingots, Cakes, or Slabs ... ... cwt. | 11,546 | 22,806 | 80,330 | 209,700 | 55,421 | 110,303 | + 54,882 | 391,888 | 967,295 | + 575,407 |
| Copper, wrought or partly wrought, Bars, Rods, Bottoms, Pans, Plates, Sheets, and Nails; and mixed or Yellow Metal for Sheathing .. " | 40,567 | 42,199 | 313,701 | 414,832 | 187,764 | 194,773 | + 7,009 | 1,466,272 | 1,892,481 | + 426,209 |
| Copper, wrought, of other sorts... " | 4,438 | 1,412 | 21,208 | 8,214 | 25,651 | 7,738 | − 7,913 | 127,208 | 50,156 | − 77,052 |
| Brass of all sorts ... ... ... " | 4,438 | 3,163 | 28,855 | 32,245 | 22,803 | 16,882 | − 5,921 | 155,729 | 162,007 | + 6,278 |
| Lead, Pig, Rolled, Sheet, Piping, Tubing, and Lead Shot tons | 2,727 | 2,179 | 26,069 | 28,285 | 58,079 | 46,486 | − 11,593 | 552,300 | 608,822 | + 56,522 |
| Lead Ore, Lead, Red and White, and Litharge of Lead ... " | 510 | 555 | 6,389 | 5,020 | 12,584 | 13,515 | + 931 | 144,262 | 120,795 | − 23,467 |
| Salt ... ... ... ... ... " | 62,953 | 67,298 | 514,735 | 505,975 | 29,136 | 31,196 | + 2,060 | 247,987 | 234,527 | − 13,460 |
| Tin, unwrought ... ... ... cwt. | 8,461 | 8,466 | 65,869 | 61,810 | 48,566 | 48,194 | − 372 | 381,256 | 361,745 | − 19,511 |
| Tin Plates ... ... ... ... " | 86,962 | 77,980 | 816,580 | 831,061 | 105,523 | 91,775 | − 13,748 | 981,964 | 973,897 | − 8,067 |
| Zinc or Spelter, wrought or unwrought ... ... ... " | 8,176 | 11,996 | 69,738 | 73,625 | 9,576 | 12,699 | + 3,123 | 70,520 | 72,985 | + 2,465 |
| | | | | £ | 2,123,752 | 2,161,259 | + 37,507 | 16,253,182 | 18,255,118 | + 2,001,936 |

## THE PURIFICATION OF PIG-IRON FROM PHOSPHORUS AND SULPHUR.

The injurious effects of phosphorus and sulphur in pig-iron is sufficiently known. A few thousandths of these substances are enough to render the puddled bars, obtained from such phosphorised or sulphuretted pig-metal, *red short* and *cold short*. But it has also been ascertained that, by refining a mixture of phosphorised and sulphuretted pig-metal, an iron is obtained in which these faults are much less apparent. Now the question is, what is the cause of this? Is it to be admitted that the phosphorus and the sulphur, brought thus together, mutually destroy each other by forming a solid or gaseous compound, which disappears either in the cinders or in the gases? Such an hypothesis is untenable; and the real cause of the defects being attenuated is that the sulphur and the phosphorus are, by the mixture of the two kinds of pig-metal (one phosphorised and the other sulphuretted), disseminated throughout a larger quantity of metal. The bars obtained by refining the mixture have the *double defect* of being red and cold short; but in such a *less degree* as allows of their being used.

This has been demonstrated by M. le Capitaine Caron, whose experiments show that the sulphur and phosphorus remains in its initial proportion in the iron made from this mixture of pig-metal. Two kinds of pig-iron were selected—one containing 1·04°/₀ of sulphur, and the other 0·85°/₀ of phosphorus—which were mixed in equal weights, melted together, and cast. The ingot obtained contained per 100 of pig-metal 0·51 of sulphur and 0·42 of phosphorus; so that no sensible quantity of either sulphur or phosphorus had been lost, but both reappeared distributed through double the quantity of metal.

This ingot of mixed metals was then refined by an addition of oxide of iron, after which operation it contained:—

| | |
|---|---|
| Sulphur, per 100 of metal .. .. .. | 0·49 |
| Phosphorus .. .. .. .. .. | 0·40 |

So that the effect of the refining, with respect to these bodies, was almost *nul.*

Lastly, a second ingot was remelted with 6°/₀ of metallic manganese, in order to ascertain if this body, which has the property of driving off the sulphur, would at the same time carry off the phosphorus. This remelted ingot showed, on analysis—

| | |
|---|---|
| Sulphur, per 100 of pig-metal .. .. .. | 0·15 |
| Phosphorus .. .. .. .. .. | 0·39 |

that is, while the proportion of sulphur was considerably lowered, that of the phosphorus remained nearly the same.

The result of the various experiments made by M. Caron, with the purpose of finding a means for eliminating phosphorus, have been fruitless. Pig-iron has a great affinity for phosphorus, and if it is brought in contact with it on its formation, particularly if the slags are silicious, the iron at once takes it up. M. Caron frequently treated by carbon ores entirely free from phosphorus, adding a little phosphate of lime and silica; and he invariably found the product to be a phosphorised metal, containing all the phosphorus that had been introduced into the crucible in the state of phosphate.

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## GEOLOGICAL SOCIETY OF DUBLIN.

At the first meeting of this Society for the present session, held on the 11th inst., the Rev. the Vice-Provost of Trinity College, Dublin, President of the Society, in the chair, Dr. T. Sterry Hunt, F.R.S., was elected an

honorary member. Two papers were read by Mr. G. H. Kinahan, of the Geological Survey;—one "On Crumpled Lamination in Shales," which phenomenon he explained by supposing the mud which forms the shale to have been deposited in an inclined plane, and then to have slidden down by the action of gravity, by which its layers became crumpled;—and another, "On the Eskers of the Central Plain of Ireland," which he divides into three classes—fringing eskers, barrier eskers, and shoal eskers—but in some places the same esker will put on the appearance of each of these three types in turn. The esker drift seems to be only a modification of the ordinary drift, which has undergone sifting to a considerable extent, the irregularities in its stratification being attributable to cross currents. The origin of some of the eskers may be directly traced to the presence of a reef in the sea where the gravel was deposited, as may be well seen in an esker lying a little south of Pallas. The author concluded by offering explanations of the formation of each of these types, and said that the presence of angular blocks of soft shale, together with rounded stones in shoal eskers, was a proof that the formation of the latter had been due to a great extent to glacial action, combined with that of marine currents. Prof. Haughton next read an important paper, "Observations on the Fossil Red Deer of Ireland, founded on the Skeletons found at Bohae, in the County Fermanagh, in 1863," which gave rise to a very interesting discussion. The last paper of the meeting was one by Mr. Ormsby, "On a Stealitic Mineral from Ballycorus," which he found to be an altered feldspar, similar to that from the same locality analysed by Mr. England, and described by Professor Haughton in vol. vi of the Journal.

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## EXTRACTION OF METALS FROM PLATINIFEROUS RESIDUES.

The mother-liquid that remains after the precipitation of platinum by sal-ammoniac always contains certain metallic residues—iron (derived from the sulphate of iron employed in precipitating the gold), lead, copper, palladium, irridium, rhodium, and platinum. M. A. Guyard proposes to extract these metals by the three following operations:—(1) the reduction of the residue to solution, (2) the precipitation of this solution by sulphuretted hydrogen, and (3) the purification and treatment of the resulting sulphides.

1st. The mother-liquids are acidulated by hydrochloric acid; and then the solid residues are fused with three times their weight of a mixture composed of equal parts of soda and of nitrate of soda. The fusion, which occupies an hour, is effected at a lively red heat in a thick iron vessel; the mass being stirred, during the last twenty minutes, with an iron spoon. The soda mixture oxidises whatever is oxidisable, and disintegrates the gangues which it in part dissolves. The fused mass is cast into an iron mould, and, after solidification, broken into fragments which are boiled in a large quantity of water in order to obtain a strong solution of soda which maintains the gelatinous acids in solution. This is separated from the insoluble acids, and saturated with hydrochloric acid. The insoluble oxides are deprived, by lixiviation, of the excess of alkali with which they are impregnated, brought to solution, and then dissolved in *aqua regia*. This solution contains iron, copper, lead, irridium, rhodium, platinum, and ruthenium. The osmium not dissolved is separated; the whole is evaporated to drive off the excess of *aqua regia*, and redissolved in water and hydrochloric acid.

2nd. The precipitation of this solution is effected by hydrochloric acid. The apparatus consists of a generator for producing sulphuretted hydrogen by the action of sulphuric acid on the sulphide of iron. This generator communicates with five large stone jars, of about 15 gallons capacity, arranged like a Woolf's apparatus—each with a special tube for the purpose

of introducing the steam required to heat its containing liquid. The entire apparatus is enclosed in a well-closed wooden stove, communicating with a chimney, the draught of which is stimulated by a furnace. The small quantities of gas not absorbed pass into the chimney by a long tube; so that all odour is avoided during the precipitation. When the operation is concluded, air is driven into the apparatus by means of gasometers. The precipitation continues about fifteen hours, during the whole of which period the temperature of the liquid is maintained at 70° Cent. (158° Fahr.). When the mother liquid has only a slight yellow tinge, due to a small proportion of soluble sulphide of irridium, the precipitation is stopped, the liquid separated from the precipitated sulphides in large wrought iron filters, and placed in a vat with iron bars on which it abandons a small quantity of irridium.

3rd. It remains to separate and treat the sulphides. They have been separated from the iron and the bodies not precipitated by sulphuretted hydrogen, but they still contain a large proportion of sulphur and of sulphides of copper and lead. These are removed by means of concentrated sulphuric acid, which reduces the sulphur to sulphurous acid and the lead into sulphate, while it has no action on the sulphides of the precious metals. This purification of the sulphides is effected in platinum vessels; and when, after long ebullition, sulphurous acid is disengaged, the refining is terminated. The mass is passed to the filters, and washed without interruption until the liquid which passes ceases to show copper or iron with ammonia. When this is completed, the sulphides are dissolved in *aqua regia*, but to avoid too energetic an action, the nitric acid of a medium strength is at first put in; when the effervescence is quieted, hydrochloric acid is added, and the whole is heated slowly to ebullition to obtain a complete solution. Lastly, a small quantity of chloride of lead is separated by deposition, and the different precious metals in the ordinary manner, by means of sal-ammoniac.

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## SOCIETY OF ARTS PREMIUMS.

The following are among the subjects for premiums named in the list issued by the Council for the sessions 1863-64 and 1864-65. Further particulars can be obtained by application to the Secretary, at the Society's House, John-street, Adelphi, London, W.C.:—

33. Clays.—For an account of the mode of occurrence, and of the uses of Cornish, Devonshire, and Dorsetshire clays, and the quantities annually worked
34. Artificial Stone and Terra Cotta.—For an account of the various artificial stones and terra cottas introduced and employed for purposes of construction, stating their properties, advantages, and im perfections, and their relative cost.
35. Lighting and Ventilating Mines.—For an account of the methods at present in use in the various coal-mining districts for ventilating and lighting the mines, with suggestions for their improvement.
36. Copper Smelting, &c.—For an account of the various commercial copper ores, of the smelting processes, and the methods by which the precious metals can be separated from copper.
37. Tin.—For an account of the treatment of tin, and its application in the arts and manufactures, and of recent discoveries of new sources of supply.
38. Wolfram.—For an account of the modes by which Wolfram can be separated from other ores; and of the uses of Tungsten in the arts.
39. Menaccanite.—For an account of menaccanite or iserine, and suggestions for obtaining titanium from these ores.

40. TITANIUM.—For the best essay upon titanium, with suggestions f-
extracting and utilising the metal.
41. SMELTING ZINC.—For an account of the processes now in use for smelting zinc ores, with suggestions for their improvement.
42. SULPHUR AND ARSENIC.—For the best account of the production of sulphur and arsenic from the metalliferous ores of the United Kingdom, with statistics of the use and export of these substances.
43. MINING MACHINERY.—For improvements in the machinery for dressing poor ores of tin, lead, &c.
44. ROPES FOR MINES.—For an account of the comparative value of chains, hemp and wire ropes, for drawing ores from mines, giving the practical results of experiments.
45. PUMPING ENGINES.—For an account of the relative merits of the different kinds of engines used for drawing water from mines.
46. PLUMBAGO.—For the discovery of graphite in Australia, of a quality and in quantity calculated to be commercially useful.
47. ALUMINIUM.—For any new or improved process for the manufacture of aluminium which, by cheapening its cost, may render it applicable to many purposes for which it cannot now be employed.
48. SILICIUM.—For the best essay upon silicium, and its uses.
49. MELTING CAST-STEEL.—For an easy and cheap method of melting cast-steel in large masses.
51. REGENERATIVE FURNACES.—For the best account of the structure and application of regenerative furnaces to manufacturing purposes.
64. STEAM COAL IN AUSTRALIA.—For the discovery, in any of the Australian colonies, and the introduction into local commerce of a good steam coal. Particulars of probable quantity available, distance of mine from shipping port, and comparative heating power and cost to be furnished.
100. OXYGEN GAS.—For a more economical process of obtaining oxygen gas than any in present use.

## Current Notes and Memoranda.

IMPROVED MIXTURE OF IRON FOR CASTINGS.—A patent has been granted to Mr. Robert Mushet, of Coleford, for improvements in the manufacture of pig-iron. When pig-iron in a melted state is subjected to the pneumatic process of refining or decarbonising, that is, by passing air through it, the metal is converted into a species of steel or semi-steel, or malleable iron, and when the iron thus operated upon is of good quality, and nearly free from sulphur and phosphorus, the steel or malleable iron obtained possesses greater toughness and tenacity when cold, than iron prepared by other processes. Mr. Mushet states that it has also been found that the metal produced from pig-iron decarbonised by this process possesses the property of communicating to other pig-iron with which it is mixed great strength, so as to render it peculiarly fitted for castings where great strength is required. Now, the present invention consists in mixing with pig iron intended for castings a quantity of steel or malleable iron, obtained by refining or decarbonising pig-iron by the pneumatic process, so as to improve the quality of the iron. The mixture is effected when these substances are in a melted liquid state. The proportion found to be most efficacious is from three to fifteen pounds of steel or malleable iron for every one hundred pounds of melted pig-iron. The steel or malleable iron which it is preferred to employ in the process is that derived from the hematite pig-iron of

Cumberland or Lancashire—the spathose pig-iron smelted from sparry ores —or from charcoal pig-iron ; but other pig-irons nearly free from sulphur and phosphorus may be decarbonised by the pneumatic process, and mixed in a similar manner.

ENGLISH *v.* SWEDISH IRON.—Experiments of an important nature have just been made at the fortress of Carlberg, in Sweden, upon the respective merits of armour plates made in England, France, and Sweden. Messrs. John Brown and Co., of Sheffield, sent two plates, one 12ft. by 2ft. 6in., and one 6ft. by 3ft. 8in. Messrs. Petin, Gaudet and Co., of Lyons, sent two plates, each of 7ft. 6in. by 3ft. 3in. The Montala Ironworks Company, of Sweden, sent two plates of 12ft. by 2ft. 6in., and one 6ft. by 3ft. 8in. All the plates were of 4½in. thickness, and then bolted to a teak target backed with iron plating, and supported by a massive stone pier. The two upper plates in the target were the French, and each was secured by 11 bolts. The next plate below was the longest, Swedish, and this was secured by 29 bolts. Below this was a tier of two short plates, one Swedish and one English, each secured by 24 bolts, and the lowest place was a long English, secured, like the Swedish, by 29 bolts. Each plate received six shots from the ordinary 68-pounder naval gun. The French and Swedish plates broke to pieces, while the English plates remained uninjured and free from cracks. The shot used were of Swedish iron, and exhibited great toughness as compared with those used in the English service—the core or centre of the shot, after striking, being of double the weight of the core of the English shot.

UNFENCED ABANDONED SHAFTS.—Mr. B. G. Davies Cooke, of Colomendy, near Mold, Flintshire, writes to the *Times*, referring to the accident that had occurred to his brother, Lieutenant J. R. D. Cooke, Royal Artillery, by falling down an old mine shaft, on the 30th of October last, as follows:— "I observed you do not appear to be aware that in a great portion of North Wales the minerals are not the property of the owners of the soil, but are held by ancient grant from the Crown, which the owners seem to consider entitles them to leave open any number of old shafts they may think fit. These in course of time get totally or partially grown over with brambles, and become frightfully dangerous. On my small property, where this sad accident took place, there are not many short of 100, with which I have nothing to do. I have applied in vain to the agents of the mineral property to abate the nuisance."

THE HARTLEY RELIEF FUND.—A meeting of the General Committee of the Hartley Relief Fund was held in Newcastle-on-Tyne, on November 14th, the mayor, Mr. Hedley, in the chair. A committee was appointed to administer that portion of the surplus of the Fund allotted to the North Durham, Northumberland, and Cumberland mining district. It was recommended to the committee so appointed to take into consideration the Miners' Permanent Relief Fund, and to assist them as far as possible. It was suggested that those funds might be helped by handing over the interest on capital annually accruing to them, reserving the capital, however, in the hands of the committee to meet such sudden calamities as those which occurred at Burradon and Hartley. It was also determined that an annual report of the state of the funds should be advertised in the papers by the committee. The administration of the Hartley Fund by the executive committee appears to have given great satisfaction ; and, after well providing for the widows and orphans, there is every prospect that the surplus handed over to the committee will prove of great service in establishing the Permanent Relief Fund, founded by the pitmen themselves—a scheme warmly supported by a number of influential persons connected with the coal trade of the district.

WELSH *versus* NORTHCOUNTRY STEAM COAL.—It has long been a keenly-contested question between the Northcountry and Welsh colliery proprietors as to which of the two classes of coal was best adapted for generating steam, and several experiments have been made by the Government autho-

rities, commencing with the well-known enquiry of Sir Henry De la Beche, without any definite result being arrived at. In consequence of the repeated applications made by the Northcountry proprietors, a series of experiments, extending over five weeks, have just been concluded at the Devonport dockyard. The Admiralty were induced to make these experiments in consequence of the assertion of the Northcountry owners that 'a judicious mixture of the Northcountry or Hartley coal with the South Wales steam coal was far superior for the purposes of steam than either taken separately. The South Wales proprietors, feeling the importance of the issue, appointed Mr. Tomlinson, locomotive engineer to the Taff Vale Railway, as their representative; and although several weeks must elapse before the official report is printed, it is confidently stated that the results will show that the superiority of the Welsh coal is fully established, none of the mixtures experimented upon coming up, in generating powers, to it taken alone. This, if established, will be a gratifying result to the South Wales owners, who, in addition to the navy, have been supplying for some time past the largest private steamship companies—such as the Royal Mail, Peninsular and Oriental, and Cunard lines, a fact relied upon as affording presumptive evidence of the superiority of the Welsh coal, as these companies have every inducement to purchase the best article in the market. It is anyhow to be hoped that when the official report of these trials is published the question of Welsh v. Northcountry steam coal will be permanently set at rest.

Manchester Geological Society.—The annual meeting of this society was held on October 29th, in the Museum, Peter Street, Manchester, Mr. J. Dickinson (president) in the chair. In their report the Council referred to the series of valuable papers which had been read during the year, and it was stated that, during that period, twenty-one new members had been elected, and the losses had been three from death and three from resignation. The meeting then proceeded to the election of officers. President—Mr. Andrew Knowles. Vice-Presidents—Mr. E. W. Binney, Sir James P. K. Shuttleworth, Bart., Mr. J. Dickinson, and Mr. Roby Barr. Mr. Binney urged the necessity of geologists collecting more specimens for the museum; and the possibility of making geological excursions in the neighbourhood of Manchester. It had also been suggested to him that the society should make a series of investigations on fire damp, and the power of the standard gauze in safety lamps to prevent the passage of flame. In the course of the discussion which followed it was stated that the flame could not be passed through the standard gauze, which was known as No. 28, but it had been passed through a No. 26. The opinion was generally concurred in that all gauzes below the standard should be condemned. The Society held their monthly meeting at the Museum, November 24th, Mr. A. Knowles in the chair. After some silurian fossils, and a collection of flint arrow-heads dug up near Lake Erie had been inspected, Mr. Wild showed the model of a new capstan hook, which by a very simple apparatus prevented any possibility of the rope slipping off. He said it was in use in his own mine, and he should have great pleasure in presenting the model to the Museum. Mr. Binney then read a paper, and the proceedings concluded.

Manufacture of Alloys of Titanium and Iron.—Mr. E. B. Wilson proposes an improvement in the manufacture of an alloy of titanium and iron, which consists in manufacturing an alloy of iron and titanium, containing also carbon from iserine in the state of titaniferous iron sand. This ore of titanium, termed by mineralogists iserine, is found in large quantities in the state of fine sand at Taranaki, New Zealand, and on various parts of the coast of Italy. Iserine is a titaniferous iron sand, consisting essentially of titanic acid combined with oxide of iron, and when smelted yields an alloy of titanium and iron. When this iserine, unmixed with any cohesive matter to agglutinate its particles, is smelted in a blast-

furnace, the iserine or titaniferous iron sand falls down through the interstices of the fuel and chokes up the hearth, and impedes the working of the furnace, so that the smelting of the ore and its reduction to the state of pig-metal cannot be properly accomplished. In order to obviate this difficulty when commencing the smelting of titaniferous iron sand, instead of using any bituminous material to agglutinate its particles, the furnace is charged with ordinary pig-iron, using as small a quantity as possible for this first operation, and when the hearth of the blast-furnace has become sufficiently filled with metal in its molten state, the furnace is tapped in the ordinary way, and the metal run into pig moulds. While in the liquid state, titaniferous iron sand, in its natural condition, is mixed with it, and when sufficiently cold is broken up into convenient pieces for charging the furnace in the ordinary way. The proportions found most convenient are one part of molten metal with two parts of the sand, and in this proportion every third charge run off would be sufficient to keep the furnace supplied. The fuel employed in the blast-furnace for the purpose of smelting iserine may be coal, coke, or charcoal, but when the alloy of titanium and iron is intended to be subsequently used for the manufacture of steel, charcoal is preferable. The blast-furnace being filled with ignited coal, coke, or charcoal, there is introduced at the filling place 4 cwts. of titaniferous iron sand or iserine, over this are placed 2 cwts. of fuel, and over this a second charge of 4 cwts. of iserine, and again over this 2 cwts. of fuel, and in this way the process of charging is kept up as the fuel burns away, and the charges work down in the furnace.

Association for the Prevention of Steam Boiler Explosions.—At the monthly meeting of this Association, on October 27th, Mr. Fletcher presented his monthly report, from which it appears that during the past month there have been examined 304 engines and 440 boilers. Of the latter, six were found to be fractured, one dangerously; eighteen in a state of corrosion, two dangerously; eight safety valves out of order; five furnaces out of shape, two dangerously; three over-pressure, all dangerously. Five boilers, not under the inspection of the association, have exploded during the past month, from which eight persons have been killed and four others injured. In one case competent inspection could not have failed to detect the dilapidated condition of the boiler; while the explosion shows that, however moderate the pressure may be, no boiler can be safely worked unless frequently submitted to a searching examination. The cause of another explosion was weakness of the flue, and of another external corrosion, the plates having been so eaten away as to be reduced to one-sixteenth of an inch in thickness.

Fluor-spar as a Flux for the Smelting and Remelting of Iron.—It is well known that the limestone employed as a flux in blast and cupola furnaces dries the slag, with which the iron—itself rendered less fluid—combines mechanically. It follows that there is a considerable loss of metal carried away in the slags, amounting to 5 °/₀ or 6 °/₀. In several of the German iron works fluor-spar is used as a flux for cupola work. Its advantages are:—a perfect fluidity in the slag, which allows the iron to pass through easily; the absence of the formation of graphite; and the greater facility with which it is detached from the walls when the furnace is being cleaned. The proportion of this flux added, per metrical quintal, is from 50 to 60 kil., or about 40 kil. for specular pig-iron. It is necessary that the fluor-spar be very pure.

New Electric Fuse.—A new electric fuse, invented by MM. Comte and Gaiffe, is spoken highly of for blasting in mines and tunnels. It differs from those which have been hitherto employed in a novel arrangement of the parts, which permits of its speedy manufacture, and reduces the chances of fracture to a *minimum*. It consists, first, of an insulated wire, to which is affixed the usual fuse tube; secondly, of another wire, uninsulated,

twisted round the first, with its extremity one centimetre (2-5th of an inch) from that of the insulated wire; and lastly, of a bag containing the explosive compound, within which are the extremities of both wires. When the induced current from a Rumkorff coil is passed through the wires, the spark passes through the powder contained in the bag. The thread of tin employed to complete the circuit in the first instance is melted instantaneously, and the spark then passes through the insulated and the uninsulated wires. By this arrangement as many fuses as may be thought fit can be attached to the two wires from the coil; for the current having passed through the first proceeds to the second, from that to the third, and so on; and since the sparks from Rumkorff's coil succeed one another with great velocity, a large number of blasts can be exploded almost instantaneously.

Wolfram as an Alloy of Cast-iron.—The experiments made by M. Guen, at the Arsenal of Brest, on the alloys of pig-iron, show a great increase of strength by the addition of about 2°/₀ of wolfram; and even on second fusion this alloy loses but very little of this acquired superiority. A mixture of equal parts of new English pig-metal with old mottled pig-iron, alloyed with 2°/₀ of French wolfram, showed an increased resistance of 44·4 kilogrammes per square centimetre (about 630 lbs. per square inch). In the case of another mixture, of one-third of the same English pig with two-thirds pieces of old guns, alloyed with less than 2°/₀ of German wolfram, the increased resistance to breakage was 67·9 kilogrammes per square centimetre (about 960 lbs. per square inch). The wolfram alloys are besides more elastic than the ordinary pig-metal, which is shown by a comparison between the lines of flexure produced by equal weights.—The wolfram should be used pulverised, but not reduced. The French ore should be subjected to a preliminary calcination, in consequence of the large proportion of sulphur and arsenic it contains; the German wolfram, being much purer than the French ore, may be employed without preparation. The reduction is effected during the fusion at the expense of the carbon in the pig-iron; M. Guen thinks that by the diminution of the carbon, and by its alloying with the tungsten, the cast metal tends to approximate to the nature of steel.

Chemical Society.—At the meeting of this Society, on Thursday, November 19th, several very interesting papers were read. Mr. Riley referred to the existence of the rare metal vanadium in English pig-iron. Vanadium has been found hitherto in very few substances, chiefly in the scarce mineral known as vanadiate of lead; it has also been detected in a kind of iron ochre, and in the French mineral beauxite, which is now so largely employed in the manufacture of aluminium. Vanadium has already received an important application in the manufacture of writing ink. The very finest black ink, perfectly indelible by chemical re-agents, or by the combined influences of air and moisture, is made by adding a minute proportion of vanadic acid to water containing some tincture of nutgalls. This ink is already in use for some special purposes, consequently a new source of vanadium is a matter of great practical importance. The next paper read was by Dr. Frankland and Mr. Baldwin Duppa. It referred to a mode of uniting the peculiar organic bases known as ethyle, methyle, and amyle with metallic mercury. The compounds produced are of high interest in a scientific point of view. One of them, although a liquid resembling water in appearance, possesses so high a specific gravity that the heaviest lead-glass floats on its surface. A paper by Dr. Thompson was next read. The properties of the well-known gas, sulphuretted hydrogen, having been alluded to, the doctor proceeded to give a description of an apparatus for producing this gas, devised by Dr. Pisani.

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Oesterreichische Zeitschrift für Berg- und Hüttenwesen. Edited by O. F. von Hingenau. Wien, Manz. (Published weekly.)

Revista Minera, Periodico Cientifico é Industrial. Edited by a Committee. Madrid, Yenes. (Published on the 1st and 15th of every month.)

Revue Universelle des Mines, de la Métallurgie, des Travaux Publics, des Sciences et des Arts appliqués à l'Industrie. Edited by C. de Cuyper. Paris and Liége, Noblet and Baudry. July and August, 1863. (Published every two months.)

Zeitschrift für Bergrecht. Edited by H. Brassert and H. Achenbach. Bonn, Marcus. 3 Heft, 1863. (Published quarterly.)

Zeitschrift für das Berg-, Hütten- und Salinenwesen in dem Preussischen Staate. Berlin, Decker. 11 Band, 2 Lief. (Published quarterly.)

# Patents relating to Mining and Metallurgy.

(*Compiled from Commissioners of Patents' Journal.—Subject matter only given.*)

## UNITED KINGDOM.

APPLICATION FOR PATENTS FROM OCT. 20TH TO NOV. 19TH.

2571 (1863). W. A. DIXON, Improvements in making aluminate of soda and other aluminous salts.

2583 (1863). G. HOWELL, Apparatus for condensing metallic and other fumes.

2600 (1863). J. MITCHELL, Improvements in sinking, quarrying, and excavating in the earth.

2630 (1863). W. LOCKE, J. WARRINGTON, W. E. CARRETT, W. E. MARSHALL, and J. TELFORD, Improvements in working coal, minerals, and earthy matters, and in the machinery employed therein.

2659 (1863). W. and S. FIRTH, and J. STURGEON, Machinery for cutting and boring coal, stone, or other minerals.

2671 (1863). G. E. DONISTHORPE, Apparatus used in getting coal and other minerals.

2725 (1863). J. THOMAS, Preparing ores and earths containing copper for smelting.

2735 (1863). G., W., and J. CRAVEN, Machinery for cutting and planing iron and other metals.

2743 (1863). J. WHITWORTH, Treatment and application of steel and homogeneous metal.

2744 (1863). H. BESSEMER, Manufacture of railway bars.

2746 (1863). H. BESSEMER, Manufacture of malleable iron and steel, and in apparatus employed.

2758 (1863). J. TOWNSEND, Manufacture of nitrate of potash.

2760 (1863). W. D. ALLEN, Improvements in casting ingots of steel.

2802 (1863). J. FOTTRELL, Improvements in deodorising petroleum and other mineral oils.

2812 (1863). A. CRAIG, Improvements in distilling hydro-carbons from coal, shale, and other bituminous substances.

2819 (1863). W. E. GEDGE (com. from J. B. BAUX and A. GUIOD), Apparatus for amalgamating the precious metals.

2837 (1863). T. HARRISON, Machinery for excavating coal and other minerals.

2852 (1863). W. E. NEWTON (com. from M. A. A. GAUDIN), Manufacture of wrought and cast-iron and steel.

2864 (1863). C. PENGILLY, Apparatus for reducing or pulverising ores and other substances.

2886 (1863). W. M. WILLIAMS, Apparatus for the distillation of coal, peat, and other substances used in the manufacture of hydro-carbons and coke.

2899 (1863). A. G. SOUTHBY, Improvements in stills for the distillation of petroleum from coal or shale.

2901 (1863). J. FRANCIS, Apparatus for washing small coal, coke, ashes, or cinders.

2902 (1863). W. H. GRAY, Construction of blast-cylinders.

2903 (1863). J. KIRKHAM, Treatment of certain ores of iron.

NOTICES TO PROCEED.

1580 (1863). T. F. PARSONS, Improvements in the mode of preparing plates, bars, and other objects of iron for being coated with metals or alloys.

1612 (1863). J. GRIFFITHS, Improvements in machinery for puddling iron and steel.

1639 (1863). J. H. JOHNSON (com. from X. F. GIRARD), Improvements in coating metal sheets with metals or alloys.

2245 (1863). M. GERSTENHÖFER, Construction of furnace for roasting pyrites.

2477 (1863). G. Parry, Improvements in refining crude pig-iron.

1888 (1863). W. and S. Firth, Improvements in machinery for working coal and other mines.

2583 (1863). G. Howell, Apparatus for condensing metallic and other fumes.

1728 (1863). W. Henderson, Improvements in treating ores and other substances containing iron, in the manufacture of iron, steel and alloys of iron, and of a purifying and deoxidising agent therefrom, also in the construction of retorts or kilns for treating the said ore and substances.

1872 (1863). A. A. A. de Rostaing, Manufacture of iron and steel with cast-iron in a divided state.

1981 (1863). J. G. Willans, Improvements in the manufacture of iron.

2448 (1863). E. Jones, Apparatus for pumping water from mines and other places.

Patents Sealed from Oct. 23rd to Nov. 18th.

1063 (1863). A. Kinder, Improvements in the manufacture of sheet metal and in ingots or plates of metal, and in machinery and apparatus employed therein.

1053 (1863) F. Bennett, Condensing lead and other metallic fumes from furnaces.

1053 (1863). B. G. Sloper, Apparatus for separating metals from earthy and other matters mixed with them.

1116 (1863). W. Walsh, Improvements in obtaining and purifying oxalate of soda, also applicable to the manufacture of oxalic acid.

1164 (1863). J. Norie, Improvements in making moulds for casting.

1234 (1863). J. T. Newton, Machinery for planishing and rolling sheet metal.

1209 (1863). R. A. Brooman, Improvements in the extraction of hydro-carburets from minerals, and in the distillation thereof.

1238 (1863). E. B. Wilson, Manufacture of iron and other metals.

1278 (1863). E. Sonstadt, Manufacture and purification of the metal magnesium.

1431 (1863). C. Niquet, Apparatus for sorting and washing ores.

1268 (1863). J. Cassell (com. from L. Martin), Treatment of mineral oils and hydro-carbons.

1295 (1863). W. Cormack, Distillation of hydro-carbons, petroleum and other mineral or vegetable oil.

1405 (1863). W. Clark (com. from J. T. Coupier), Distillation and separation of hydro-carburets.

Patent on which £50 duty has been paid, Oct. 24th.

2612 (1860). T. Cobley, Manufacture of white lead (carbonates of lead).

Patents on which £100 duty has been paid, from Nov. 2nd to Nov. 11th.

2585 (1856). H. Bessemer, Manufacture of rails and railway bars.

2639 (1856). H. Bessemer, Manufacture and treatment of iron and steel.

2596 (1856). C. Titterton, Manufacture of zinc and zinc white.

2798 (1856). A. V. Newton, Improved machinery for forging iron.

Patents become Void by non-payment of duty, from Oct. 17th to Nov. 14th.

2473 (1860). F. C. Bakewell (com. from J. Reese), Improvements in furnaces.

2483 (1860). J. A. West, Treatment of solutions containing sulphate of soda, metallic and other matters.

2531 (1860). D. A. Leyshon, Improvements in coating iron, steel, or zinc.

2557 (1860). A. G. Hunter, Improvements in treating sulphurets.

2647 (1860). C. Crockford, Manufacture of spelter from the sulphuret of zinc.

2650 (1860). J. Dreyfus, Improvements in rolling iron.

2700 (1860). G. Hinton, Manufacture of iron, steel-iron and steel, from certain waste products.

2702 (1860). P. Spence, Improvements in separating copper from its ores.

2703 (1860). J. MITCHELL, Manufacture of cast-iron pipes, tubes, and rollers.
2731 (1860). T. COBLEY, Method of treating poor ores of copper.
2741 (1860). S. FOX, Improvements in furnaces for melting steel and other metals.
2764 (1860). W. C. FORSTER, Improved method of manufacturing soluble silicate of potash.
2777 (1860). M. L. HENRIONNET and L. O. BOBLIQUE, Treatment of mineral phosphates of lime.
2793 (1860). T. A. BLAKELY, Improved method of increasing the strength of steel and wrought-iron.
2403 (1856). R. A. BROOMAN (com. from MM. MURTINEDDU & Co.), Improved method of and composition for splitting rock, stone, and earth.
2650 (1856). W. CLARK, Manufacture of barytes, strontian, and their salts.
2671 (1856). W. GREEN and T. STOREY, Apparatus for washing or cleaning coal.
2680 (1856). J. KINNIBURGH, Improvements in moulding or shaping metals.

## INDIA.

GRANTED UNDER ACT VI, 1856, DATED FROM NOV. 25TH, 1856, to FEB. 9TH, 1857.

13. H. BESSEMER, Manufacture of iron and steel.
14. H. BESSEMER, Manufacture of malleable iron and steel.
30. F. UCHATIUS, Process of manufacturing cast-steel.

GRANTED UNDER ACT XV, 1859, DATED FROM MAY 11TH TO SEPT. 24TH, 1860.

35. J. P. FARRAR, Manufacture of cast-steel and iron.
41. W. EDWARDS, Self-acting break apparatus for winding coals, metals, or other materials from pits or shafts of any depth.

## COLONY OF VICTORIA (AUSTRALIA).

PATENTS FROM SEPT. 2ND, 1859, TO DEC. 21ST, 1861.

432 (569). G. OAKEY, J. HUNT, and J. M. OPIE, Machinery for washing auriferous soils.
433 (570). E. CHAMBERS, Improvements for working stamps for stamping minerals.
435 (572). J. POLKINGHORNE, Invention for separating gold from quartz, clay, slate, earthy and mineral matters.
439 (576). F. ASHTON, Improvements in working stamps.
443 (580). M. KING, Machinery for amalgamating metals.
444 (581). R. BARRATT, Improvements in quartz stamping batteries, and in the amalgamation and separation of metals.
447 (584). C. LEICESTER, Extraction of gold and silver from quartz, mundic, or iron pyrites, and any other rock or substances in which they may be found.
449 (586). E. HENDERSON and J. F. DROOP, Improvements in copper, iron, and wire sieves used in crushing quartz or other minerals.
453 (590). W. NEWTON, Machinery for extracting gold from quartz and other earthy matters.
454 (591). C. F. CAMERON, Method of obtaining gold from quartz.
458 (595). H. D. CROKER, Separation of gold or other minerals from their dross, quartz, or earthy matters.
461 (598). J. and H. W. LANGLANDS, Construction of stamper boxes for stamping minerals.
464 (601). G. H. F. ULRICH, Treatment of auriferous mineral substances.

## AUSTRIA.

PATENTS GRANTED, PROLONGED, AND BECOME VOID DURING SEPTEMBER.

437. A. WALL, Apparatus for purifying lead and separating the silver therefrom. [Granted.]

326. J. K. Schemmann, Manufacture of raw, cast, and refined steel from cast-iron. [Prolonged.]

425. G. Kolb, Method of boring rock by means of a wire rope. [Become void.]

428. F. Tempsky, Manufacture of extract-coals. [Become void.]

## BAVARIA.

### Patent Delivered June 3rd.

39. Heufeld Chemical and Agricultural Society, Manufacture of extract of mother-lye from the salt-works of Upper Bavaria.

## BELGIUM.

### Patents Delivered Oct. 15th.

14,983. D. Clauzet, Mode of fastening miners' lamps.

14,995. E. Solvay, Apparatus for the direct manufacture of carbonate of soda.

14,997. A. Masson, Improvements in casting metal into sheets.

15,006. M. Gerstenhöfer, Furnace for roasting pyrites and other sulphurous ores.

15,008. E. D'Arcet and Co., Mode of purifying hydro-carburets.

15,016. R. Mushet, Manufacture of iron and steel.

15,017. R. Mushet, Treatment of iron and steel made by the pneumatic process.

15,038. N. J. Lebrun, Parachute of mines.

15,059. F. Lemut, A puddling machine.

15,067. W. Gerhardt, Manufacture of iron and steel.

15,074. R. Mushet, Moulds for casting steel or homogeneous iron.

## FRANCE.

### Current List of Patents.

58,029. Bessemer, Apparatus for the manufacture of malleable iron and steel.

58,067. Latry and Co., Processes for obtaining white oxide of zinc from zinc of commerce.

58,081. Artige and Deroide, Machines for extracting gas, and blast-engines.

58,083. Cassell, Alembics for distilling petroleum and other thick oils.

58,084. Chadefaud, Moveable cone for charging blast-furnaces.

58,085. Coupier, Mode of separating combined hydro-carburets, and their sub-product.

58,115. Borie, Conglomerating dust of mineral fuel.

58,134. De Rostaing, Manufacture of iron from pig-iron in a state of division.

58,140. Verstraet, Extraction of sulphur from earthy sulphates, pyrites of iron and copper, blende, and galena.

58,177. Bradfer, Substituting a gas recipient at the mouth of blast-furnaces for funnels and plunging.

58,195. Meynier, Manufacture of sulpho-cyanide of ammonia.

58,196. Micol and Chaillot, Sen., Smelting and casting metal into hollow or solid pieces.

58,209. Barnes, Apparatus for shaping, rolling, and pressing metals.

58,252. Laporte, Revolving ore-cleaner.

58,276. Girard, Machine for tinning, leading, and zinking iron, copper and other metals.

58,285. Payan and Gibert, Blast-engine with a double air-current.

58,348. Vieille Montagne Company, Applying Siemen's gas-heating apparatus to Belgian zinc-furnaces.

58,368. Muller and Co., Improvements in the direct manufacture of iron and steel.

## NETHERLANDS.

### Current List of Patents.

1. A. Nikllon, Manufacture of artificial basalt.

## PRUSSIA.

### Patent Delivered Sept. 10th.

8. E. Schmidt, Machine for the manufacture of tin plate.

## SAXONY.

### Patents Delivered from July 29th to July 31st.

2. C. G. Clemm, A method of obtaining the sulphates of alkalis and alkaline earths by means of magnesia and certain compounds of the same, and of converting the corresponding carbonates by obtaining sulphur.

7. Rolle, Construction of vertical retorts for the dry distillation of brown-coal and other bituminous minerals.

## UNITED STATES.

### Patents Issued from Oct. 6th to Oct. 27th.

40,207. W. S. Wright, Improvement in charcoal furnaces.
40,325. E. Chipman, Improvement in crushing presses.
40,362. S. E. Sanborn, Exploding mines.
40,388. J. Baur, Improved alloy of copper, zinc, and aluminium.
40,406. T. Hansbrow, Improved amalgamation.

## SPECIFICATIONS PUBLISHED, AND PRICES.

### From Oct. 24th to Nov. 14th.

*** Specifications will be forwarded by post on receipt of price and postage at Her Majesty's Patent Office, 25, Southampton Buildings, London, W.C.—The amount of postage may be estimated from the price, as follows:—Where price does not exceed 1*s*. 6*d*., postage will be 1*d*.; above 1*s*. 6*d*., and not exceeding 3*s*. 4*d*., it will be 2*d*.; above 3*s*. 4*d*., and not exceeding 6*s*. 4*d*., it will be 4*d*.—Sums exceeding 5*s*. must be remitted by P. O. O., on Holborn Office, payable to *Bennet Woodcroft.*

521 (1863). W. Readman, Manufacture of carbonate of magnesia and iodine from kelp; 4*d*.

522 (1863). E. B. Wilson, Manufacture of alloys of titanium and iron; 4*d*.

543 (1863). P. Spence, Manufacture of potash and alum; 4*d*.

546 (1863). J. Humby (com. from H. Felsch), Furnaces for manufacturing oxide of zinc; 8*d*.

551 (1863). H. Fehr, Treating mineral oils; 4*d*.

560 (1863). V. D. Delahaye, Excavating coal and rock; 10*d*.

568 (1863). S. Williamson, Furnaces; 8*d*.

611 (1863). W. Clark (com. from L. D. Verstraet and C. Schmid), Manufacture of sulphuric acid; 1*s*.

625 (1863). E. B. Wilson, Manufacture of steel; 4*d*.

646 (1863). R. Mushet, Manufacture of cast-iron; 10*d*.

679 (1863). J. Polkinghorne, Treating tin ores; 4*d*.

708 (1863). W. E. Newton (com. from E. G. Boigues and P. Rambourg), Manufacture of iron and steel; 4*d*.

738 (1863). J. Saunders and J. Piper, Manufacture of tin plates; 2*s*. 6*d*.

742 (1863). W. Reay, Amalgamating minerals; 6*d*.

# Trade Review of Mining, Quarrying, and Metallurgy.

## WESTERN COUNTIES.

THE prosperous tone we noticed last month in Cornish mining has scarcely been maintained. The copper standard advanced 5*l.* in the beginning of the month, but again declined 5*l.* at the sale of the 12th and 19th,—leaving off as it opened. This drop is generally attributed to the stringent state of the money market, which has necessarily influenced all markets where heavy stocks are held. The tin market also continues depressed, seriously affecting the position of the large tin producing mines of the county. Within three years, the tin standard has altogether declined 27*l.*, making a difference of about 300,000*l.*, a year, on the value of the black tin produced in Cornwall. In the case of a mine like Dolcoath, returning nearly 90 tons of black tin per month, the fall equals a loss of nearly 25,000*l.* a-year. As there is no extra supply of tin, this fall is difficult to account for, but is most probably due to the very unhealthy state of the market, consequent on the transition state from the close monopoly of recent times to the half-and-half state of things now existing. In fact, as things stand, the system of selling the black tin by private contract is wholly indefensible, and must sooner or later be abandoned for an open ticketing. At present the supply of tin to the smelters is a patronage in the hands of the pursers of mines, which they generally use for their own personal purposes. If the capital by which Cornish mines are worked were to a great extent local, it might be difficult to object to this; but considering that three-quarters of it is derived from outside shareholders, it seems too bad that their interest should be sacrificed to the petty considerations that now influence the sale of tin.

The scheme for reworking the *Crenver and Wheal Abraham* mines, which has been in preparation for three or four years, has been at last launched, as a limited liability company, with a capital of 150,000*l.*, in 30,000 shares, of which it is stated that only 11,000 remain to be allotted. It seems that 9,500*l.* is to be paid for the setts. There is no doubt that these mines are a moderately fair speculation; but the experience of the county has been against the reworking of old deep mines, every one of which recommenced within the last twenty years have signally failed—for instance Great Alfred, Wheal Vor, Great Crinnis, and many others. In this case the direction is respectable, including Mr. Brydges Willyams, of Truro; Mr. W. Cox, M.P. for Finsbury; and Mr. Clarke, Purser of Great Work Mine. The Messrs. Willyams are bankers at Camborne, and of course the working of a mine like Crenver and Abraham would be of great importance to them, as well as to the Hayle merchants, who have also taken a considerable interest.

A discovery was reported in the early part of the month in the old Hallenbeagle part of *Great Wheal Busy.* At *Wheal Seton* the sump winze sinking under the 150 is looking very well, worth upwards of 20 tons per fathom. *Nanjiles* is reported to continue to look well. At *Great North Downs* a good lode of copper is said to have been discovered in the western part of the old mine. At *Camborne Vean* there has been a great improvement in Gryll's shaft, which has been reported worth 100*l.* per fathom, and a rise in the back of the 242 is reported to be worth from 50*l.* to 60*l.* per fathom.

At the last South Frances account, on Nov. 2, a jubilee was celebrated on the declaration of the *one hundredth* dividend, within 17 years. The chairman (Mr. R. R. Broad) stated that during the twenty years, since 1843, in which the mine had been productive, the gross value of the copper raised

reached the large amount of 450,358*l*., and the tin, 34,560*l*. The dues paid to the lords (Mr. Basset and Sir R. R. Vyvyan) were no less than 32,328*l*., and the dividends paid to the adventurers nett 183,626*l*., or 370*l*. 13*s*. 6*d*. per 1-496th, against the original cost of 18*l*. 18*s*. 9*d*. This mine, as is well known, is involved in the protracted litigation with West Basset; but it may not be generally known that their leases, which expire about the middle of next year, are not yet renewed. Indeed, if the litigation should not be completed before the leases expire, there may be considerable difficulty about their renewal.

At *West Great Work* meeting (on Oct. 24th) it was resolved that an engine be purchased and erected forthwith. At *East Treskerby* meeting (on Nov. 4th) a resolution was passed authorising the committee to deal with the shares in arrear as they may deem most beneficial to the company. At *St. Ives Wheal Allen* meeting (in reply to an application made by Mr. Pyne, agent of the Mornington property, on Nov. 5th) it was resolved that, while the adventurers would be glad to meet the wishes of the lords in appointing agents recommended by them in the mine, they submit that the adventurers should be allowed to appoint such agents as they may consider most suitable, and in whom they have confidence. At *Charlotte United* meeting (on Nov. 12th) Mr. T. P. Tyacke was appointed purser, in the place of Mr. Hosking, resigned. At *Wheal Hope* meeting (on Nov. 19th) it was resolved to erect a steam-whim and crusher immediately.

The new companies announced during the month are:—The *Crenver and Wheal Abraham United Copper Mining Company* (limited), with a capital of 150,000*l*., in 30,000 shares of 5*l*. each, above referred to. A prospectus has been issued of the *North Chiverton Silver Lead Mining Company*. This undertaking is formed on the cost-book system, and is in 6,000 shares upon which a call of 1*l*. per share is made. The *Plym River Slab and Slate Company* (limited) has also issued a prospectus, with a capital of 60,000*l*., in 10,000 shares of 6*l*. each.

## WALES AND THE BORDERS.

South Wales.—The iron trade has steadily improved throughout the month, stocks are being reduced, and business generally appears to be getting into a really healthy state. All the iron-works are in full operation, while at some even more hands could be well employed. The ironmasters have a large amount of orders on their books, and are able firmly to maintain their prices. The puddlers have commenced working at the rise of 10 per cent. in their wages, and those of the other operatives have been raised from 5 to 10 per cent. It was hoped that this advance would check the extraordinary emigration which has now been going on for some months past; such, however, is not the case, and emigration still continues without any prospect of diminution.

It is stated on good authority that Mr. T. P. Price has purchased the Pontenewyndd works for the Millwall Iron Company. These works have been carefully inspected, and it is proposed in the first place to make use of them for the manufacture of iron bars and slabs, which will then be forwarded to Millwall, and there rolled into armour plates. There has also been a report that the Penydarren works, Merthyr, which have been at a stand-still for several years, are to be put into operation early next year.

In the London Gazette of November 3rd, a dissolution of partnership is announced of the firm of Messrs. F. Bankart, H. Bankart, and A. Bankart, Briton Ferry, Glamorgan, and Clement's-lane, Lombard-street, coppersmelters (so far as regards A. Bankart).

The coal trade has decidedly improved, and buyers are now preparing

in earnest to purchase their stocks for the cold weather. At the beginning of the month the house-coal trade suffered somewhat from the small number of vessels entering the ports, on account of the bad weather, but it has since improved. Since the opening of the direct Swansea and Neath railway, which connects the steam-coal collieries of Aberdare with the port of Swansea, trade has greatly increased. There has been, and still continues, an immense demand for the steam-coal of the Aberdare district, in fact the proprietors are unable to keep pace with it, and there have been many vessels on demurrage in consequence of being unable to get cargoes within the appointed time. The colliers, seeing that the demand and prices were increasing, called a meeting in order to take into consideration the advisibility of applying for an advance of wages. The meeting was numerously attended, and it was determined that a deputation from each colliery should wait on the masters, and apply for a rise in the present scale of wages. It has been rumoured that the men came to the conclusion to strike unless their demands were complied with, but this is incorrect, and, on the contrary, several of them expressed their disapprobation of a turnout, whatever might be the result of the application. The returns of coal raised in the parish of Aberdare for the quarter ended September, 1863, show an increase in the coal-get as compared with that of the previous quarter of 35,394 tons. The total quantity of coal raised during the past quarter was 552,590 tons; of this 490,017 were exported, and the remaining 62,573 tons were used at the local ironworks. These figures do not represent the quantity of coal raised in the Aberdare valley, the parish of Aberdare not extending throughout the whole of the district popularly known as the Aberdare basin.

The trade of the South Wales ports during the month of October suffered slightly from the unfavourable weather which prevailed, but the returns upon the whole were satisfactory and encouraging. There were 418 vessels engaged in the trade of Swansea during the month, with an aggregate registered tonnage of 54,205 tons, and the shipping rates received amounted to 1,349*l.* 3*s.* 3*d.*, against 416 vessels, with a registered tonnage of 48,655 tons, and 1,148*l.* 5*s.* 6*d.* in shipping dues, in the corresponding month of last year. Neath and Briton Ferry exported 19,250 tons of coal, coke, and culm, 723 tons of bar iron, 294 tons of tin plates, 86 tons of copper, and 413 tons of miscellaneous, making a total of 20,775 tons, against 20,929 tons in the corresponding month of last year. The total imports, including 5,429 tons of iron ore, 3,202 tons of copper ore, 1,355 tons of pig-iron, reached 11,883 tons, against 9,298 tons in the corresponding month of last year. A large quantity of steam-coal and iron was exported from Newport during the month, and an average trade was done at Llanelly.

In making up the returns of the Bill of Entry Office at Cardiff, it seems that the exports of coal during the month of October have been altogether unprecedented in the history of that port. Within last month no less than 150,270 tons of coal were exported to foreign ports, principally to the Mediterranean, French, Italian, Austrian, Russian, and Norwegian ports. Of this immense quantity no less than 11,060 tons were taken away by 26 ships on the 10th ult. The other exports were 8,348 tons of iron, 1,950 tons of patent fuel, 341 tons of coke, and the number of ships conveying these aggregates was 429, of which 144 were British, 118 French, 52 Italian, and 33 Austrian. The corresponding month's return of 1862 shows that the exports were 100,923 tons of coal, and the quantity exported last month consequently shows an increase of 49,347 tons of coal. The exports of the previous months of this year were:—January, 103,006 tons of coal and 9,528 tons of iron; February, 115,890 coal and 12,669 iron; March, 122,517 coal and 12,688 iron; April, 128,541 coal and 21,519 iron; May, 98,391 coal and 16,680 iron; June, 95,108 coal

and 15,649 iron ; July, 136,259 coal and 23,237 iron ; August, 131,122 coal and 14, 422 iron ; September, 137,049 coal and 9,668 iron. The total quantities which have been exported during the ten months of this year are 1,217,873 tons of coal and 144,408 tons of iron. During the ten months of 1862 the quantities were 1,108,710 tons of coal and 115,998 tons of iron ; the same period of 1861 was 940,266 tons of coal and 117,678 tons of iron ; and of 1860 they were 940,275 tons of coal and 148,110 tons of iron. During the whole of 1857 the total quantity of coal exported was 752,376 tons ; in 1858 (the year of the strike), 650,344 tons ; in 1859, 786,118 tons ; 1860, 911,441 ; in 1861, 1,123,657 ; in 1862, 1,200,500 ; and the ten months of the present year, as has been previously stated, 1,217,873 tons of coal. In iron the quantities have been :—1861, 132,493 tons ; 1862, 146,187 ; and during the ten months of the present year, 144,408 tons of iron. These figures give ample proof of the rapid advancement of the demand for Welsh steam-coal, Cardiff being by far the greatest outport of the produce of Welsh collieries.

Among the arrivals into Swansea may be mentioned :—Copper ore and copper regulus from Bolivia, Coquimbo, Santiago de Cuba, Huasco, and Carrisal Bajo ; silver ore from Huasco, and iron ore from Cherbourg.

The inquest on the bodies of 34 of the men killed by the recent Morfa colliery explosion was held at Aberavon, on November 17th, before Mr. A. Cuthbertson, coroner. Only two witnesses were examined, Francis Cole, whose duty it was to clean the lamps, and William Barris, inspector of the lamps. Their evidence went to show that near the body of Peter Sutton was found his lamp, unlocked, but in such a condition as to make it certain that it had not caused the explosion. Both the witnesses were of opinion that the only probable way of accounting for the explosion was to suppose that a fall had taken place, and that by this fall the lamp of one of the men had been broken, thus igniting the gas. The inquest was adjourned till all the remaining bodies are found.

Gloucestershire.—The imports into Bristol include :—342 tons of sulphur ore from Pomaron, 257 tons from Arklow, and 520 tons from Newfoundland ; 103 tons of silver-lead ore from Plymouth ; 13 barrels of roll sulphur from Liverpool ; 60 tons of railway iron from Port Talbot ; 260 tons of pig-iron from Glasgow and Belfast, 400 tons from Greenock, and 482 tons from Archangel ; 40 tons of tin-plates fron Newport ; 1,323 bars of lead from Alicante ; and 350 pigs of lead from Malaga. The exports include :—375 tons of coal, and 160 tons of iron. In the month of October 981 tons of coal and 4,261 tons of iron were exported over sea from Bristol, against 801 tons of coal, and 4,545 tons of iron in September, showing an *increase* of 180 tons of coal, but a *decrease* of 284 tons of iron. During the corresponding month last year, 504 tons of coal and 173 tons of iron were exported from Bristol. In the month of October the customs' duties amounted to 103,121*l.* 0*s.* 7*d.*, and the number of vessels entering the port with cargoes was 122, whilst 21 vessels cleared outwards with cargoes.

Among the imports into Gloucester may be noticed :—140 tons of sulphur ore from Pomaron ; 210 tons of coal from Landshipping, and 50 tons from Llanelly ; 120 tons of bar-iron from Briton Ferry, and 180 tons from Swansea. The exports comprised 1,192 tons of iron ; 367 tons of coal, and 64 tons of burnt ore.

The *Gloucestershire Smelting Company*, to be incorporated with limited liability, and a capital of 70,000*l.*, in shares of 5*l.* each, has issued its prospectus.

North Wales. — The *Kenyon Colliery Company*, with a capital of 40,000*l.*, in shares of 10*l.* each, has issued its prospectus. The property is situated near Ruabon, comprises about 90 acres, and is a sound undertaking. This project has since been abandoned in consequence of having received an inadequate support, probably due to the tightness of the money market.

A prospectus has been issued of the *Queensferry Alkali Company*, with a capital of 50,000*l.*, in shares of 100*l.*, to carry on the manufacture of alkali and other chemicals at Queensferry.

A prospectus has also been issued of the *Anglesea Colliery Company* (Limited), with a capital of 35,000*l.*, in 7,000 shares, of 5*l.* each, with the object of working the Berw Colliery.

A call of 2*l.* is to be paid on the shares in the Hendre Ddu Slate and Slab Quarry Company (Limited) by the 28th of January.

## MIDLAND COUNTIES.

STAFFORDSHIRE AND WARWICKSHIRE.—It is some time since so great an activity has taken place in the coal market as during the last month, and it has been found impossible to meet the demand prevailing throughout South Staffordshire and East Worcestershire, even at the advanced rates which buyers willingly give. One great impediment is the scarcity of hands; at many of the works twice the number of men could be employed. The coal masters are not, however, making such large profits as might be expected, high prices of coal being accompanied with high wages to miners.

The iron trade has fully maintained the improvements which it has experienced for the last two months, and some of the masters have orders in hand sufficient to last till February. Prices have been well kept up, and all orders under the full list rates are declined. The foreign trade has been rather quiet towards the end of the month, but this is usual at this time of year. A difficulty is also felt here as in the coal trade with respect to the workmen, caused by the puddlers refusing more than an advance of 3*d.* per day to the underhands out of the 2*s.* which they have themselves secured. Many of the underhands have kept away from work in consequence, resulting in a serious loss to the iron-masters. Scotch pig-iron has been firm, and prices have advanced. There has not been much doing in the market this month, as orders for the present quarter have been executed; but consumers are now beginning to send in orders for the next quarter. Ironstone has also been quiet but maintains high prices.

LEICESTERSHIRE.—The inquest on the bodies of the three men who lost their lives by the inundation of the Collorton Colliery on October 8th, was resumed on November 17th. The evidence adduced upon this occasion was mainly scientific.

NOTTINGHAMSHIRE.—An inquest was held on October 27th, at Eastwood, on the body of Thomas Clifford, a collier, who met with his death in one of the pits belonging to Messrs. Barber and Walker, at Eastwood. A few days previously the deceased was engaged in his usual work in the pit when a portion of the roof fell upon him and crushed him so dreadfully that he died in a few days.

## NORTHERN COUNTIES.

NORTHUMBERLAND AND DURHAM.—There has been a healthy tone in the general trade of the Tyne during the month.

The coal trade was rather quiet at the commencement of the month but it has since become more brisk; in consequence of the mildness of the weather the ports of North Europe are open, and the steam-coal trade is therefore more active than might have been anticipated. The recent gales have caused the loss of several collier vessels. Great excitement has been caused by the strike at the Auckland collieries, the property of Messrs. Straker and Love. The principal complaint made by the colliers was that they were paid according to the measure of the coal sent up, not by the

weight. Their wish was to be paid by weight, to which the masters were willing to accede, offering them 9¼*d.* per ton for working. The men demurred at this reduction, and sent in their own prices, varying at the several collieries on strike, but in none less than 1*s.* per ton. Two or three disturbances have taken place, but the general body of miners appeared to disapprove of such proceedings. Mr. Love has already made several concessions, and it is hoped that the strike will soon terminate. The men seem to be getting tired of the dispute, and are wavering between allegiance to the Union and acceptance of Mr. Love's proposals.

The iron trade is extending with great rapidity, fifteen new furnaces are about to be commenced in the Cleveland district, and if the trade continues to increase for the next ten years at the same rate as it has been doing for the last few years, Teesside will in every probability become the largest iron-making district in the kingdom.

The exports from the Tyne include:—123,059 tons of coal; 9,577 tons of coke; and 54,289 tons of iron. Among the imports during the month have been:—Cargoes of pyrites from Dordt, Sevanger, Antwerp, Drontheim, Lalasa, Cadiz, and Pomaron; three cargoes of manganese from Huelva; 11,709 bars of lead from Carthagena, and 2,838 from Garrucha; 5,668 bars of iron from Gothenburg, and 50 tons from Gefle; 195 tons of ore from Pomaron; sulphur ore from Dantzic, 228 tons of iron ore from Garrucha; and lead ore from Cagliari.

YORKSHIRE.—The demand both for coal and coke has been very good, although, in consequence of the unsettled state of the mining population throughout South Yorkshire, the operatives have not worked their full time, and the proprietors have been obliged in some instances to fall back upon their stock, which at this period of the year are never very large. One or two of the collieries have slightly advanced the prices of house coal.

The inquest upon the bodies of the unfortunate men who met their death in the Edmunds' Main Colliery on the 8th of December has been brought to a conclusion. The jury gave the following verdict:—"We find that James Ellis came to his death by suffocation caused by an explosion of gas in the Edmunds' Main Colliery on Monday, the 8th December, 1862, and we are of opinion that the cause of the explosion was owing to the dangerous use of gunpowder in blasting the coal in the dip boardgates in this mine, which practice of blasting ought not to have been permitted by the managers or prosecuted by the workmen after the system of wedging was introduced." The foreman handed the following recommendation to the coroner, and expressed the hope that it would be forwarded to the Home Secretary:—"We are of opinion that, until a regular inspection of the mines by government takes place, accidents will be of frequent occurrence in the collieries in this immediate neighbourhood."

LANCASHIRE.—The depression which has prevailed in the coal trade for many months appears at last to be passing away. The large stocks of coal on hand have been considerably reduced, and the same necessity does not, therefore, exist for the restriction of the "get" which the masters have been compelled to insist upon. The partial revival of the cotton trade has no doubt had much to do with this improvement in several quarters; but even in those places where the demand is not regulated by the number of mill furnaces which require feeding, the reports are more than usually satisfactory. This being the case, the men at work in each of the Lancashire coal-fields are simultaneously moving for an advance of wages. The only point on which the masters are likely to join issue is as to whether the present improvement can be looked upon as likely to be progressive. The Wigan coal-owners have met and declared by resolution that the present prices and the state of the trade do not justify an advance; but they promise a further consideration of the question at the opening of the year.

Notwithstanding this, however, the men are to assemble in a mass meeting to decide on a united course of action. This is now the more possible, because of the existence of an extensive union which receives the support of the bulk of the miners. Still this association is as yet but a small one, having been established but a year or two ; it cannot, therefore, have any large funds to fall back upon in case of a lengthened struggle, and it may be added to this that the bulk of the delegates are opposed to a strike except as a last resource.

## SCOTLAND.

The good demand for coal, both for home use and for exportation, which existed last month still continues, and a large amount of business has been transacted.

The market for all kinds of bar-iron has remained firm throughout the month, and the advance in prices has been fully maintained. At the beginning of the month, buyers were not inclined to give out orders at the extreme advance, in hopes of a reduction before the winter is over, but they have since come forward more freely. Makers are still fully employed, and many are pressed for the delivery orders received. The pig-iron market, which improved slightly at first, closes rather flat, but the tightness in the money market, coupled with a falling off in local consumption, has as yet only caused a reduction of 9*d.* per ton.

The following are the shipments for the first ten months of 1863, as compared with the corresponding periods of 1862, 1861, and 1860:—

| Month. | 1863. | 1862. | 1861. | 1860. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| January.. .. .. .. | 30,467 | 44,729 | 39,267 | 38,625 |
| February .. .. .. | 38,867 | 39,614 | 33,070 | 26,883 |
| March .. .. .. .. | 50,909 | 44,495 | 33,474 | 39,152 |
| April .. .. .. .. | 57,345 | 63,160 | 62,622 | 50,585 |
| May .. .. .. .. | 67,820 | 70,461 | 82,036 | 66,701 |
| June .. .. .. .. | 53,806 | 42,167 | 57,201 | 40,712 |
| July .. .. .. .. | 51,181 | 41,581 | 48,304 | 47,846 |
| August .. .. .. .. | 59,534 | 57,025 | 54,460 | 64,216 |
| September .. .. .. | 56,153 | 49,079 | 39,516 | 52,697 |
| Week ending Oct. 4 .. .. | 14,136 | 8,871 | 11,683 | 8,157 |
| " " 11 .. .. | 16,171 | 9,677 | 11,983 | 10,974 |
| " " 18 .. .. | 12,674 | 9,309 | 14,434 | 11,641 |
| " " 25 .. .. | 15,772 | 6,518 | 9,656 | 7,136 |
| Total .. .. | 524,835 | 476,686 | 495,736 | 465,325 |

The increase this year, as compared with 1862 and 1860, has been about 10 °/ₒ, and, as compared with 1861, somewhere about 6 °/ₒ. Such a result must be regarded as eminently satisfactory.

## AUSTRALIA.

VICTORIA.—The advices received by the *Port Phillip* Company from their resident director, Mr. Bland, at Clunes, give the following results of the operations up to the 23rd of September last:—Four weeks' return, August.— Quantity of quartz crushed, 3,150 tons ; yield per ton, 10 dwts. 19 grs. Receipts, 2,690*l.* ; payments, ordinary, 936*l.*, and on account of new stamps,

690*l*.—total, 1,626*l*. Profit, 1,064*l*. Quartz crushed in six weeks in September, 4,700 tons, yielding 2,270 ozs. gold, or 9 dwts. 16 grs. per ton. Remittance, 1,500*l*.

Not much has been recently heard of the coal seams of this colony, but we believe those of Cape Paterson are kept in view, and an outlay is determined on to make them available.

SOUTH AUSTRALIA.—The directors of the *English and Australian Copper* Company have advices from their manager, dated 26th of September last. The quantity of coal at Kooringa was 210 tons, at Kapunda, 670 tons, and at Port Adelaide, 1,727 tons, besides about 280 tons of wood at Kooringa. There were four furnaces at work at Kooringa, and five furnaces and one refinery at the Port, and the smelting operations were progressing satisfactorily.

The directors of the *Bon Accord* Company have advices dated the 25th of September. The shaft it was resolved to sink in the south-west corner of the property had been commenced and sunk to the depth of 10 fathoms. The ground to the depth attained, proving easy for sinking.

The directors of the *Kapunda* Company have advices to September 26. The ores raised in July were 300 tons of 18½°/$_o$ average produce, equal to 55 tons of pure copper, exclusive of 100 tons of sulphur ore for flux. The quantity raised in August, estimated at 400 tons good percentage. The Buhl shaft had been sunk to 70 fathoms; it was expected that when the pumping arrangements were completed the mine would be effectually unwatered to that level, at which it was intended to commence cross-cuts to intersect the various lodes. All going on steadily at smelting works, the furnaces being in full work, and a large supply of fuel coming in. The make of copper for August was 77 tons, of which 41½ tons had been shipped per the Monarch, and 31 tons per the Norfolk, and freight had been engaged for 120 tons per the Coonatto.

From *Yudanamutana* directors have advices to the same date. The traction engines had been satisfactorily tried. At Yudanamutana the Big Bunch is yielding the same quantity of ore; at Wheal Gleeson there is a decided improvement; and also at Section 1,379. There are 45 tons dressed ore (from 35 to 40°/$_o$) at surface, and 600 tons good ore to dress, besides 200 tons 16°/$_o$ ore, and 200 tons coarse ore. At Blinman mine the lode has gradually opened into a rich bunch of ore, from which 500 tons 25°/$_o$ ore have been raised, and on the whole the mine never looked better. During the month, 67 tons have been sent to port; there are 100 tons to dress, and about 300 tons piled for smelting. Altogether during the month, ore enough has been raised to make 75 tons of copper.

WESTERN AUSTRALIA.—From *Fortune* there are advices dated 30th August. The men and machinery by Hastings were reported to have arrived well. Old shaft sunk to 40 fm. level, lode producing 3½ tons per fm.—level south-west 4 tons; but water having increased, it was necessary to suspend operations until engine is erected and pit-work fixed. Stopes range from 2 to 4 tons of copper and lead ore per fms. Ores dressed during month, 25 tons copper and 13 tons lead; copper ore in store at Bay, 100 tons.

NEW SOUTH WALES.—There has been no further developement of the goldfields of this colony, and trade is rather dull. The most expansive branch of colonial enterprise just now is the development of the coalfields. Many new mines have been opened, and the competition has led to a reduction in price, as well as to an improvement in quality. According to the *Newcastle Chronicle* the quantity of coal shipped from that port during the month ending July 17, was 36,507 tons—of which 12,012 tons went coastwise to Sydney, and 24,495 tons to foreign countries. The total quantity shipped from the colony during the same period was 40,863 tons, so that the Newcastle district, exclusive of Lake Macquarie, show a return

of $\frac{9}{10}$ths of the whole coal shipped in the colony. The price charged at the staiths being 12*s.* 6*d.* per ton, the value of the monthly transactions would thus be 22,817*l.* Of exports from the colony, the largest was to Victoria, which took upwards of 8,000 tons, and next in importance come San Francisco and Otago; indeed, if all the shipment to New Zealand be taken together, they show little less than Victoria. The San Francisco demand can scarcely be hoped to be retained, in consequence of the discoveries of coal in Vancouver's Island.—In the Illawarra district the progress of the mines seems to be slow.

## CONTINENT OF EUROPE.

France.—There has not been much doing in refinery pig-iron at St. Dizier, but still some transactions have been concluded, of which the deliveries are to be effected, either at the Vignory or Bologne stations. The prices in these transactions indicate a rise, though the improvement has not yet been very marked. Altogether the French iron trade exhibits a general amelioration.

There has been a satisfactory demand for coal in the French departments of the Nord and the Pas-de-Calais, and prices, although stationary, have shown a good deal of firmness. During the past month the activity in orders has assumed goodly proportions in consequence of the approach of winter. A new and reduced tariff for the carriage of coal, coke, and boghead has been submitted for official approval by the Eastern of France Railway Company.

A rich vein of ironstone has been discovered in the department of the Aube by M. Aubrat. Researches have not yet been made to a sufficient extent to indicate the full importance of this discovery, but tolerably conclusive analyses have been made as to the strength of the mineral in metallic matter. The first of these analyses (which were made by the engineer of mines at Angers) showed 76°/o of peroxide of iron, 24°/o of silica, some traces of lime, and no signs of phosphorus or sulphur. The second analysis showed 72·53°/o of oxide of iron, 14·20°/o of gangue, 13·27°/o of water, and neither lime, sulphur, nor phosphorus.

Belgium.—The Belgian metal market continues in a satisfactory state, and the demand for pig-iron has been very active for some time past. The forge-masters are declining all orders for rails, unless better terms are accorded to them. Very great activity has prevailed in the Charleroi district, and many of the forge-masters intend extending their means of production. All the puddling furnaces are in full work, and the erection of several new ones is contemplated.

Prussia.—Between 1834 and 1862 there were established in Prussia 89 companies for the working of mines and metallurgical establishments, with a share capital of 104,885,067 thalers. The development taken successively by these establishments may be divided into four periods—the first, before the promulgation of a law passed in 1851, and which comprises the lapse of time from 1834 up to 1852; the second comprising the years 1852, 1853, and 1854; the third comprising the years 1855, 1856, and 1857; and the fourth comprising the years 1858, 1859, 1860, and 1861. From 1834 to 1851, 14 companies were formed, with a capital of 25,303,334 thalers, while from 1852 to 1854 17 were organised, with a capital of 26,516,733 thalers. In the next three years the work of joint-stock organisation proceeded with accelerated rapidity, 42 companies having been formed, with a capital of 44,185,000 thalers, while from 1858 to 1861 only 16 companies were established, with a capital of 8,880,000 thalers. The year 1856 alone saw 22 companies formed, with a capital of 24,005,000 thalers, and 1857 witnessed 17 new companies, with a capital of 13,060,000 thalers. These figures show that in Prussia, as in France, the six years

from 1852 to 1857 inclusive were distinguished by an incessant creation of new workings. Those six years were in fact the period of a kind of industrial fever throughout Europe.

ITALY.—A prospectus has been issued of the *Mining Company of Italy*, with a capital of 50,000*l.*, in shares of 5*l.* each, the primary object being to purchase and work a silver-lead mine at Ballabio, near the Lake of Como. The payment is to be 22,000*l.*, half in cash and half in shares.

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## NORTH AMERICA.

CANADA.—Very favourable accounts continue to be received of the prospects of the recent gold discoveries in the Chaudière district. Some claims are reported to have met with great success—men having earned upwards of $1,000 each in three months. The Clerk of the Crown Domains at Quebec estimates the quantity of gold raised during the three months working in the spring, at $18,000 at least—got by 100 men, who would thus, on a average, have earned $2 per day. The gold has hitherto been all found in alluvial washings, no quartz mining operations having been yet undertaken, although the existence of quartz veins, said to show gold, has been remarked in the neighbourhood of the Devil's Rapids. A discovery of antimony is said to have been made in the township of Ham; discoveries of gold and silver quartz at Tyendinago, in the county of Hastings, and further discoveries of copper in the rich belt of country extending northward from Lake Memphremagog to Point Levi. Lead deposits, said to be of unusual richness, are also spoken of in Hastings county. In the short space of half-an-hour 40 lbs. of pure soft lead was taken from a hole about 2 ft. deep and 3 ft. in circumference. The Marmora iron and copper mines are also again about to be worked by a new company, principally from Quebec, who purpose commencing operations with a capital of $1,000,000, half of which is expected to be got in the Northern States.

WESTERN (UNITED) STATES.—The discovery of extensive lead mines in Missouri is now an established fact; and in Franklin and Washington counties working men are already earning $25 per day in its extraction. Land, with all mining rights, can be bought at from $5 to $10 per acre (1*l.* to 2*l.*).

In the Lake Superior iron ore trade, from the opening of navigation in May to the 25th September, there were shipped from Marquette iron ore in these quantities, to wit :—

| | | |
|---|---|---|
| By the Jackson Iron Company .. | .. | 58,285 gross tons. |
| " Cleveland Iron Company .. | .. | 38,690 " |
| " Lake Superior Iron Company | .. | 62,038 " |
| Total for season | .. | 159,013 " |

Two new iron companies—the Excelsior, and New England Iron Mining Companies—have commenced working with great spirit.

The copper region of Upper Michigan is also full of activity and progress. The completion of the Philadelphia and Erie Railroad to Erie City, and the establishment of direct communication from thence to the mineral districts of Upper Michigan and Lake Superior are opening these out to the capital and enterprise of the Eastern States. Several new companies are starting, generally organised in from 20,000 to 50,000 shares, and principally supported by capital from New York or Philadelphia.

Silver lead discoveries are also reported in the vicinity of Marquette, Michigan, in the granite in veins bearing north and south. Four com-

panies are already organised—three of which are called the Silver Lead, the Silver Lake, and the Eldorado. In some of these companies, the shares are brought out as low as 25 cents per share (1*s.* sterling at par of exchange, but only about 8*d.* at the present rate of gold).

NOVA SCOTIA.—A new company, called the Cheticamp Copper Mining and Smelting Company of Cape Breton, Nova Scotia, has been formed at Philadelphia. The mine, which is situated on the north-west coast of Cape Breton island, has been reported on by Mr. William Petherick, mining engineer, of Philadelphia. It extends over 640 acres of ground, and a rich sulphide, imbedded in clay-slate and quartz, is said to be found within 6 ft. of the surface.

CALIFORNIA AND BORDER TERRITORIES.—The discovery of silver-bearing lodes is reported in the *Idahoe Territory*, and a San Francisco Company was incorporated towards the end of last September, to work a mine in this locality.

The boundary commissioners, now running the line between California and Nevada Territory, have determined that Aurora City lies in the territory, and Honey Lake Valley in the State. As mining rights, both in the State and Territory, seem to be involved in an inextricable sea of litigation, the practical effect of this determination is rather important—transferring, for instance, four-fifths of the mines of the Aurora district from the jurisdiction of the Californian courts.

One company in California, called the *Humboldt Peak Gold and Silver Mining Company*, has been incorporated in San Francisco, with a capital of $3,960,000 (800,000*l.*), in 3,960 shares of $1,000 each.

The *Allison Ranch* Mining Company are reported to have taken out 500 ounces of gold in a crushing of 24 hours.

Sulphuric acid works have been recently erected, and commenced working at Carson (Nevada), which are expected to supply the territory at much less cost than the imported article.

## SOUTH AMERICA.

CHILI.—For some years past two extensive copper mines in Chili have been worked under the management of Mr. Sampson Waters, of Falmouth, and it is now proposed to form a limited liability company—the *Chilian Mining and Trading Company*—with a capital of 300,000*l.*, in shares of 10*l.* each, to purchase and work them. The mines in question are the San Pedro and the Descubridora, the former of which is said to have yielded profits to the amount of 210,000*l.* during the seven years ending March, 1863, and shows every promise of giving an amount considerably above the average in the present year; whilst the latter, which is in course of development, is proved to contain ore similar in character to that at San Pedro, and has two years' reserves laid open. The San Pedro Mine is situated about fifty miles from Chanaral, whence the ore is shipped; it is held by permanent grant from the Chilian Government, free of royalty, but subject to a duty of 5 °/$_{\circ}$ upon copper exported. The mine is opened to the depth of 100 fms., and the average width of the lode is upwards of 40 ft. It has been rich from surface, the ore being principally a grey sulphide, yielding about one-third metal. The Descubridora Mine is about twenty-eight miles from the coast, the shipping port for the ores being Pan d'Ascucar, ten miles north of Chanaral. The main lode varies from 30 to 90 ft. wide, all the workings are productive, and the two-thirds which will be transferred to the company is estimated to yield over 20,000*l.* profit for the current year. From Descubridora there has been shipped, since March 31, about 43,000*l.* worth of ore, and the latest advices report discoveries within the last three months adding very considerably to its value.

The quantity of copper exported from Chili continues to fall off. In the

province of Atacama the quantity shipped, in ores, regulus, and slab, was—in August only 18,104 quintals, against 30,772 quintals in August, 1862; and 27,000 quintals in July last.

BRAZIL.—The directors of the *St. John Del Rey Mining Company* (Limited) have received, by telegram from Lisbon, the following report, dated Morro Velho, Sept. 28:—Produce eleven days of September, 13,172 oitavas; yield, 7,081 oitavas per ton; remittance, 81,614 oitavas. Working regularly.

## Record of the Mining and Metal Markets.

### METALLIC-ORE MARKETS.

TIN.—The black tin standards have been reduced 3*l*. since our last, and now stand at:—

| | | | |
|---|---|---|---|
| Superior Fine | .. £107 .... | Superior Common | .. £104 |
| Second Fine | .. 105 .... | Second Common | .. 103 |

The standard still continues very unsettled, and indeed a good deal of uncertainty seems to exist as to what the standard really is.

COPPER.—At the four Cornish sales we give this month, the number of tons, average produce, quantity of fine copper, average price per ton, and standard have been as follows:—

| *Date.* | *Tons.* | *Produce.* | *Fine Copper.* Tons. cwt. | *Price per ton.* | *Standard.* |
|---|---|---|---|---|---|
| Oct. 29. | .. 2,986 | .. 6⅜ .. | 190 5 .... | £5 5 0 .... | £125 9 0 |
| Nov. 5. | .. 2,977 | .. 6⅝ .. | 196 13 .... | 5 14 0 .... | 128 1 0 |
| „ 12. | .. 2,626 | .. 6⅝ .. | 174 3 .... | 5 10 6 .... | 124 13 0 |
| „ 19. | .. 6,179 | .. 5⅝ .. | 348 0 .... | 4 10 0 .... | 128 11 0 |

The copper standard advanced greatly during the first part of the month, but afterwards as rapidly declined. At the sale of Oct. 29th, it advanced 1*l*. 10*s*.; at that of Nov. 5th, 3*l*. 10*s*.; but at the sale of the 12th it declined 3*l*., and again at that of the 19th about 2*l*., leaving the standard much the same as last month.

LEAD.—Comparing this month's sales with those of last, we find that prices have advanced in several instances.

### COAL MARKETS.

LONDON, *November 27th*.—From the returns of the Registrar of the London Coal Exchange, of the quantity of sea-borne coal, culm, and cinders, imported into London in the month of October, we learn that the total quantity was 309,614 tons, against 302,845 tons during the corresponding month of last year,—showing an *increase* of 6,769 tons.

The following are the particulars of the 309,614 tons imported during October:—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Newcastle .. | 118,095 tons, in | 297 ships | | Scotland .. | 1,451 tons, in | 8 ships |
| Seaham .. | 17,407 „ | 71 „ | | Wales .. | 6,216 „ | 14 „ |
| Sunderland . | 97,318 „ | 235 „ | | Yorkshire .. | 3,115 „ | 18 „ |
| Middlesbro'. | 6,831 „ | 24 „ | | Small .. | 2,727 „ | 7 „ |
| Hartlepool.. | 63,038 „ | 195 „ | | Cinders .. | 1,585 „ | 13 „ |
| Blyth .. | 1,519 „ | 6 „ | | Duff .. | 317 „ | 1 „ |

The quantity of coal imported by railways and canals during the month of October was 193,491 tons, against 135,455 tons during the corresponding month last year—showing an *increase* of 58,036 tons.

Very little business was done in the London coal market until quite the close of the month, when a considerable amount of transactions was reported. On October 30th, the new ships arrived were 42; there was little change in the market from last month's closing quotations. The prices were:—Hetton Wallsend, 20*s.*; Braddyll's Wallsend, 18*s.* 6*d.*; Lambton Wallsend, 19*s.* 6*d.*; Eden Main, 17*s.* 6*d.*; Butes Tanfield Moor, 15*s.*; Tees Wallsend, 17*s.* 3*d.*; Steward's Wallsend, 18*s.* 6*d.*; South Kelloe Wallsend, 17*s.* 6*d.*; Hasting's Hartley, 16*s.* 6*d.*; West Hartley, 17*s.* 6*d.* On November 2nd, new ships 32, market dull. On the 4th, the fresh arrivals were mostly steamers. 2nd class dull, and declined 3*d.* On the 6th, new ships 56, market quiet; Hartley's scarce, and advanced 6*d.* On the 9th, new ships 180, market brisk; Hartley's reduced 3*d.* On the 11th, new ships 22, market firmer; Hartley's dull, and again declined 3*d.* On the 13th, new ships 73, business moderate. On the 16th, new ships 85, market very heavy. On the 18th, new ships 58, market still depressed, with a reduction of 6*d.*; Hartley's heavy, and declined 3*d.* On the 20, new ships 38, a further reduction of 6*d.*; Hartley's advanced 3*d.* On the 23rd, new ships 40, marked depressed; Hartley's reduced 3*d.* On the 25th, new ships 19, market still much depressed, a general reduction of 6*d.* On the 27th, new ships 35, the tone of the market stronger, and in some instances an advance of 3*d.* The prices were:—Hetton Wallsend, 18*s.* 6*d.*; South Hetton Wallsend, 18*s.* 6*d.*; Haswell Wallsend, 18*s.*; Tees Wallsend, 18*s.*; Braddyll's Wallsend, 17*s.* 6*d.*; Eden Main, 16*s.* 9*d.*; Belmont Wallsend, 16*s.* 6*d.*; Heugh Hall Wallsend, 16*s.* 9*d.*

LIVERPOOL.—From Messrs. J. and T. Platt's Coal Circular for October, we find that the quantity of coal, cannel, coke, and patent fuel shipped from Liverpool to foreign and colonial ports during the month of October was 64,727 tons, against 50,747 tons during the corresponding month of last year—showing an *increase* of 13,980 tons. The total shipments from January to October were 472,434 tons, against 523,222 tons in the corresponding period last year—showing a *decrease* of 50,788 tons. The exports coastwise during October were 12,140 tons, against 8,571 tons during the same month last year—showing an *increase* of 3,569 tons. The total exports coastwise from January to October were 86,232 tons, against 69,206 tons during the corresponding period of last year—showing an *increase* of 17,026 tons.

CONTRACT FOR COAL.—The Admiralty require the supply of 5,000 tons of South Wales coal for the use of steamers at Jamaica, and 3,000 tons for the steam ships at the Cape of Good Hope.

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## SHARE MARKETS.

LONDON, *November 28th.*—A fair amount of business was transacted in the London share market during the early part of the month, but this was checked towards the close by the tightness in the money market, and the drop in the standards of copper and tin.

*Wheal Seton* shares have been considerably dealt in during the month, although at one time prices went back 30*l.* They opened on the 30th at our last closing prices of 180*l.*-185*l.*, but declined almost daily until the 9th, when they were quoted as low as 150*l.*-155*l.* They then began to improve, and by the 23rd reached 190*l.*-195*l.*; there has been, however, another slight decline, the closing price being 170*l.*-175*l.* *West Seton* shares have declined from their opening quotations of 220*l.*-230*l.* to

205*l.*-210*l.* *North Crofty* shares have also slightly declined during the month and close at 5*l.*-5¼*l.* *Wheal Agar*, 3*l.*-3¼*l.* *West Tolgus*, 52½*l.*-57½*l.* *New Seton* shares have receded from 105*l.*-110*l.* to 85*l.*-90*l.* *North Roskear*, 22*l.*-23*l.* *Roskearnoweth*, 3¼*l.*-3¾*l.*

*New Rosewarne* shares have been considerably dealt in, but prices have not fluctuated to any very great extent. They opened on the 30th at 25*l.*-26*l.*, being a reduction of 3*l.* from our last closing quotations. On the 2nd they improved 10*s.*, but after that day began to recede and continued doing so until the 12th, when they were as low as 16*l.*-18*l.* After that they rose rapidly on the 16th to 23*l.*-25*l.*, when they were in prominent demand. There has been a daily fluctuation in prices ever since, and shares close flat at 20*l.*-21*l.* *Great Wheal Fortune* shares have receded about 7*l.* during the month; they opened at 26*l.*-28*l.*, and close 19½*l.*-20½*l.* *East Lovell* shares opened at 6¼*l.*-6¾*l.*, and rose gradually until the 23rd, when they were 10½*l.*-11*l.*, but have since declined, and close at 8½*l.*-9*l.* *Providence*, 44*l.*-45*l.* *Basset and Grylls*, 19*l.* to 21*l.* *Wheal Grylls*, 30*l.*-31*l.* *Rosewall Hill and Ransome United*, 3½*l.*-3¾*l.* *Calvadnack*, 5*l.*-6*l.* *Wendron Consols*, 10*l.*-11*l.* *Great Wheal Vor*, 11*l.*-11½*l.* *Wheal Kitty* (Lelant), 13½*l.*-14½*l.* *East Grylls*, 8½*l.*-9½*l.* *Rosewarne United*, 1⅞*l.*-2⅛*l.* *Wheal Margery*, 4½*l.*-5*l.* *St. Ives Consols*, 30*l.*-32*l.* *East Providence*, 4¼*l.*-4½*l.* *Trencrom*, 3½*l.*-4*l.* *Prosper United*, 4½*l.*-5*l.*

There has not been very much doing in *West Chiverton*, but shares have slightly advanced; they opened on the 30th at our closing prices of 51*l.*-53*l.*, and after but little fluctuation close at 54*l.*-55*l.* *Herodsfoot* shares have advanced from 35*l.*-36*l.* to 39*l.*-40*l.* *Chiverton* shares have declined from 11*l.*-11½*l.* to 9½*l.*-10*l.* *East Chiverton* shares have also declined from 7*l.*-7½*l.* to 6*l.*-6½*l.* *Chiverton Moor*, 6¼*l.*-6¾*l.* *Wheal Ludcott and Wrey*, 1¾*l.*-2¼*l.* *Wheal Trelawney*, 21*l.*-22*l.* *Wheal Mary Ann*, 12*l.*-12½*l.* *Wheal Hope*, 4¼*l.*-4¾*l.* *North Shepherds*, 2¾*l.*-3*l.*

*East Russell* shares have fluctuated considerably, having advanced in the early part of the month from their opening quotation of 3¼*l.*-3½*l.*, until the 18th, when they reached 6½*l.*-6¾*l.*, after which they commenced to recede, leaving off at 4⅞*l.*-5⅛*l.* *Drakewalls*, 35*s.*-37*s.* *Wheal Crebor*, 1¾*l.*-2*l.* *Devon Great Consols*, 550*l.*-560*l.* *Kelly Bray*, 12*s.* 6*d.*-17*s.* 6*d.* *New Wheal Martha*, 2¼*l.*-2¾*l.* *Hingston Down*, 2*l.*-2½*l.* *North Robert*, 7*s.* 6*d.*-10*s.* *East Gunnis Lake and South Bedford*, 17*s.* 6*d.*-22*s.* 6*d.* *West Maria*, 3½*l.*-4*l.* *Furze Hill Wood Consols*, 5*s.*-10*s.* *West Martha*, 1⅜*l.*-1½*l.* *Bedford United*, 2¼*l.*-2¾*l.* *Wheal Arthur*, 5*s.* 6*d.*-6*s.* 6*d.*

*West Frances* shares sprang into demand about the middle of the month, and prices advanced from 18*l.*-20*l.* to 30*l.*-32½*l.* On the 23rd they were quoted at 32½*l.*-35*l.*, but suddenly declined to their closing price of 27½*l.*-30*l.* *South Frances* shares have declined from their opening quotation of 65*l.*-70*l.* to 62½*l.*-66*l.* *Wheal Basset* shares have advanced from 75*l.*-80*l.* to 90*l.*-95*l.* *East Basset* shares have receded from 70*l.*-72*l.* to 62*l.*-63*l.* *Wheal Grenville*, 5*l.*-5½*l.* *Wheal Buller*, 24*l.*-26*l.* *North Basset*, 2⅞*l.*-3*l.* *East Grenville*, 3⅜*l.*-3⅝*l.* *North Buller*, 3½*l.*-4½*l.*

*East Caradon* shares have been flat, and there has been no change in them worth noticing. They opened on the 30th at 26¼*l.*-26¾*l.*, and close at 26*l.*-26½*l.* *Glasgow Caradon Consols*, 4*l.*-4½*l.* *West Caradon*, 18*l.*-19*l.* *South Caradon*, 410*l.*-415*l.* *South Caradon Wheal Hooper*, 12*s.* 6*d.*-17*s.* 6*d.* *Caradon Vale*, 3*l.*-3½*l.* *Marke Valley*, 6⅜*l.*-6⅝*l.* *Gonamena*, 2¼*l.*-2⅜*l.* *West Fowey Consols*, 15*s.*-25*s.*

*Camborne Vean* shares have been largely dealt in, and prices have advanced from 2⅞*l.*-3*l.* to 3*l.*-3¼*l.* *Cook's Kitchen* shares, which opened at 21*l.*-22*l.*, at one time advanced to 25*l.*-26*l.*, but receded again to 21*l.*-22*l.* *Tincroft*, 19*l.*-19½*l.* *Stray Park*, 33½*l.*-34½*l.* *Wheal Crofty*, 3*l.*-3½*l.* *Wheal Harriett*, 1½*l.*-2*l.* *South Crofty*, 23*l.* *West Stray Park*, 3*l.*-3¼*l.* *Condurrow*, 105*l.*-115*l.* *South Condurrow*, 11*s.*-13*s.*

*Clifford Amalgamated* shares have declined from our last prices of 39*l.*-40*l.*, and close at 36*l.*-36½*l.* *St. Day United* shares have risen from 23*s.*-25*s.* to 34*s.*-36*s.* *Nanjiles* shares at one time receded to 25*l.*-26*l.*, but recovered again, closing at the opening quotation of 29*l.*-30*l.* *North Grambler*, 3⅝*l.*-3⅞*l.* *Grambler and St. Aubyn*, 12*l.*-13*l.* *Great Wheal Busy*, 3¾*l.*-4*l.* *East Carn Brea*, 6¾*l.*-7¼*l.* *Wheal Uny*, 5¾*l.*-6*l.* *South Carn Brea*, 2*l.*-2½*l.* *Carn Brea*, 69*l.*-71*l.* *South Tolgus*, 37½*l.*-40*l.* *Great South Tolgus*, 4⅝*l.*-4⅞*l.* *North Downs*, 1½*l.*-1¾*l.* *Great North Downs*, 2½*l.*-3¼*l.* *Wheal Union*, 3*l.*-3¼*l.*

Transactions are also reported in the following mines :—*Wheal Kitty* (St. Agnes), 7¼*l.*-7½*l.* *East Rosewarne*, 2⅜*l.*-2⅝*l.* *Pendeen Consols*, 6¾*l.*-7¼*l.* *Tolvadden*, 27*s.* 6*d.*-30*s.*

Prices have been quoted in Welsh mines as follows :—*Long Rake*, 4*l.*-4½*l.* *Bryn Gwiog*, 32*l.*-33*l.* *North Minera*, 7*s.*-8*s.* *Central Minera*, 2¼*l.*-2½*l.* *Trimley Hall*, 12*s.* 6*d.*-15*s.* *Prince of Wales*, 5*s.*-7*s.* 6*d.*

Among Foreign and Colonial mines the following have been quoted :—*Cape Copper*, 5¾*l.* *Fortuna*, 3½*l.* *United Mexican*, 6⅛*l.*-6¼*l.* *Yudanamutana*, 2½*l.*-2⅝*l.* *Cobre Copper*, 27*l.* *East Del Rey*, 1*l.* *St. John Del Rey*, 59*l.* *Scottish Australian*, 12*s.* 6*d.* *Santa Barbara*, 12*s.* 6*d.* *Don Pedro North Del Rey*, 17*s.* 6*s.* *Port Phillip*, 1¼*l.* *Montes Aureos*, 2⅝*l.*-2¾*l.* *General*, 22¼*l.* *Linares*, 7*l.* *Maraquita*, 12*s.* 6*d.* *Vallanzasca*, 17*s.* 6*d.* *Alamillos*, 10*s.* *Kapunda*, 1¼*l.* *Vancouver*, 5¼*l.*

CORNWALL.—The Cornish mining share market has on the whole been very active, and a fair amount of business has been transacted. *New Rosewarne* shares have fluctuated between 20*l.* and 25*l.* *St. Day United* shares have been dealt in at 2⅛*l.* *Camborne Vean* shares have been in request at 3¼*l.*-3⅜*l.* *Great Wheal Fortune* shares have been flat at 22*l.*-23*l.* *Wheal Emily Henrietta* shares have improved to 10*l.*-10½*l.* *North Crofty*, 23*l.*-24*l.* *Condurrow*, 100*l.* *Carn Brea*, 69*l.*

DUBLIN.—The Irish mine share market has increased considerably in activity during the past month, though towards the end the high value of money has had the effect of depressing the prices of shares. *Wicklow Copper* shares have been in great demand, and have shown very little variation. They have been quoted at 12*l.*-15*l.* *Mining Company of Ireland* shares have fluctuated slightly, and close at 19¼*l.*-19⅜*l.* *Connorree* shares have been largely dealt in at from 16*s.* to as high as 23*s.* 6*d.* *General Mining Company of Ireland* shares were very quiet during the month until the end, when they fell 15*s.*, and business was done at 3¾*l.*-3⅞*l.* There has been a rise in *Carysfort* shares which opened at 20*s.* 6*d.* and close at 22*s.* 3*d.*

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## METAL MARKETS.

LONDON, *November* 28*th*.—The metal market has been characterised by considerable animation all through the month; there has been a large demand for several descriptions, and prices in some instances have considerably improved.

IRON.—The iron trade has been very active during the past month, and a very extensive business has been done in all descriptions.

There has been great excitement in the Scotch pig-iron market. Prices opened at 62*s.* cash, 63*s.* three months prompt. In the middle of the month quotations gave way to 60*s.* 6*d.* cash, but recovered again towards the end, when an enormous amount of business was done at 66*s.* 3*d.* cash, 67*s.* three months prompt.

Welsh bars have been very firm, and makers being full of orders are not disposed to take any more except at the highest rates. Staffordshire descriptions obtain full rates.

STEEL remains without alteration.

COPPER.—There has been a very steady market for this metal all through the month, with very few second-hand parcels to be had under official prices. Business in foreign has been neglected. Burra Burra, 100*l.* Kapunda, 102*l.* Chili, 90*l.*

YELLOW METAL.—There is nothing to report on this article, which remains unaltered at our last quotations.

TIN.—The market for English has been very dull all through the month, indeed in the middle of the month was obtainable at from 3*l.* to 4*l.* under official rates, and on the 23rd the smelters reduced the price 3*l.* per ton all round. Foreign has also been very flat at lower quotations. Straits has receded from 115*l.* 10*s.* cash, 117*l.* three months, to 113*l.* cash, 115*l.* three months. Banca, 117*l.* The Dutch market has been flat at 68 fl.

TIN PLATES.—Prices of this article have been well maintained; good coke plates 23*s.* 6*d.* to 24*s.* in Liverpool, and charcoal 28*s.*

LEAD has been steady, and a fair amount of business has been done.

SPELTER.—In the beginning of the month very little business was done in this article, but towards the middle a good demand sprang up, and the market closes much firmer. Hull parcels, 18*l.* 5*s.*

LIVERPOOL, *November 27th.* IRON.—The iron market opened flat at 61*s.*, but on the 17th a large business was done at irregular prices, closing on that day at 63*s.* 9*d.*, sellers. Since then the market has been very quiet, the closing quotation being 62*s.* 9*d.*

GLASGOW, *November 27th.* IRON.—There has been great excitement in the pig-iron market during most of the past month, and a very large amount of business has been transacted at advanced rates. The market opened firm at 61*s.* cash, 62*s.* 3*d.* three months, and continued very steady until the 17th, when prices advanced to 63*s.* 1½*d.* cash. After that prices continued to advance with a large business doing, closing firm at 66*s.* 3*d.* cash.

PARIS, *November 21st.* COPPER.—This metal has maintained its firmness, and prices show an upward tendency. English, 247½ fr. Chili, 232½ fr.

TIN.—The market for this article is weaker. Banca, 302½ fr. Straits, 297½ fr. English, 287½ fr.

LEAD remains unaltered.

SPELTER has been very quiet at unaltered prices.

COLOGNE, *November 23rd.*—There is little to report in the metal market, which has been very quiet. Prices generally remain unaltered, lead and pig-iron showing an upward tendency.

AMSTERDAM, *November 21st.* TIN.—Banca has been done at 67 fl.

BRESLAU, *November 21st.* SPELTER.—The market for this article has been quiet all through the month, and 6,000 ctrs. of Godulla spelter have been disposed of at the reduced price of 5 thlrs. 4 sgr. For W. H. 5 thlrs. 10 sgr. have been asked.

HAMBURG, *November 19th.* IRON.—Scotch pig-iron, 2¾ mk. English in bars, 5¾ mk. Staffordshire descriptions, 6½ to 7 mk. Swedish, 8¼ to 8½ mk.

COPPER.—This metal has been in fair demand, and prices have somewhat advanced. Demidoff, 72 mk. Burra Burra, 68 mk. English, 73 mk.

TIN.—Prices of this metal have shown a downward tendency, and a very trifling amount of business has been transacted. Banca, 13 sch. English, 13¾ sch.

LEAD.—This article has rather advanced in price. German, 13½ to 12¼ mk. English, 14½ to 15¼ mk.

STETTIN, *November* 21*st*. COPPER.—Swedish, English, and American, 33 to 35 thlrs.

TIN.—Banca, 44 thlrs.

LEAD.—This metal has been firm at 7⅞ to 8 thlrs.

BERLIN, *November* 21*st*. IRON.—Scotch pig-iron, 52 sgr. English, 45 sgr. Staffordshire descriptions, 5½ thlrs.

COPPER.—The market for this metal has been firmer, owing to the small quantity in hand. Mansfield refined, 35 thlrs. Burra Burra, 34 thlrs. English, 32 to 32½ thlrs.

TIN remains flat, and in little demand. Banca, 41 thlrs. English, 38 thlrs.

SPELTER.—A very small amount of business has been transacted in this article. Ordinary sorts, 5¼ thlrs. W. H., 5 thlrs. 11 sgr.

HONGKONG, *October* 15*th*. LEAD.—Sales have been made at $6·60 to $6·80 for common, and $6·80 to $7 for best quality.

IRON has been in rather better demand, and sales amount to 9,000 piculs. Quotations are:—Nailrod, $2·65 to $2·70; hoop, $3·30 to $3·55; bar, $2·60 to $4·30; wire, $9·50 to $12.

FOOCHOW, *October* 6*th*. LEAD.—2,000 piculs against tea, $8 per picul.

SHANGHAI, *October* 8*th*. LEAD.—5-3 to 5-7 taels; nailroad iron, 1-9-5 to 2-1-5 taels.

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*Furnished by Von Dadelszen and North*, 158, *Leadenhall Street, London, E.C.*

The metal market during the past month has exhibited many features of striking interest, and a most important advance in the value of some articles has been established in the face of adverse political news and a tight money market.

IRON.—An enormous business has been done in every description of iron. Welsh makers are full of orders, and are unwilling to enter orders for forward delivery except at a considerable advance upon present rates. We quote bars in Wales at 6*l*. 15*s*. to 7*l*. 5*s*., according to brand. Rails are 10*s*. higher at 6*l*. 15*s*. to 7*l*. also in Wales. In Staffordshire descriptions full rates are freely paid for large parcels, and a further advance is not improbable. In Scotch pigs an immense amount of business has been done. In the first week of the month there were indications of a steady advance in this article, which the rise in the Bank rate of discount affected but little, and from 60*s*. 6*d*. cash a steady improvement has taken place from day to day with but slight fluctuations until we are now enabled to report an enormous business as having been done up to 66*s*. 3*d*. cash and 67*s*. three months, closing at the highest. A very firm market and spirited buying.

COPPER is firm. Smelters exact full rates, and but few second-hand parcels are to be had under official prices. Makers are well supplied with orders for manufactured. Foreign is firm with but little doing. We quote Burra 100*l*.; Kapunda, 102*l*.; Chili, 90*l*.

TIN.—This metal has been very dull all the month, and on the 23rd the smelters reduced the official price of English 3*l*. per ton all round; the present price of common block and ingot is 112*l*., of bar 113*l*., and of refined 117*l*. per ton. The fall had been anticipated for some time, and foreign had gradually declined from, in Banca, 119*l*. to 114*l*. 10*s*., the present price, and in Straits from 114*l*. 10*s*. to 113*l*. for cash. The Dutch market has also declined from 70 fl. to 66½ fl. the 50 kilos.

TIN PLATES are unaltered but very firm, and full rates are demanded.

LEAD has improved about 10*s*. per ton.

SPELTER is about 7*s*. 6*d*. dearer, at 18*l*. 7*s*. 6*d*. to 18*l*. 10*s*. for spot parcels, with a better demand.

## LONDON PRICES CURRENT OF METALS.

**From Messrs. James and Shakspeare's, 10, Austin Friars, E.C., 27*th Nov.***

| | | | | | |
|---|---|---|---|---|---|
| | | | | Per Ton. | |
| IRON | Bars (Welch) .. | in Wales .. | £7 0 0 | @ | £7 5 0 |
| | „ „ .. | „ Liverpool | —— | „ | 7 10 0 |
| | „ „ .. | „ London | —— | „ | 7 15 0 |
| | Nail Rods „ .. | „ Wales . | —— | „ | 7 10 0 |
| | „ (Staffordshire) | „ Liverpool | 8 5 0 | „ | 9 0 0 |
| | „ „ | „ London | 8 15 0 | „ | 9 10 0 |
| | Hoops „ | „ Liverpool | 9 10 0 | „ | 10 0 0 |
| | „ „ | „ London | 10 0 0 | „ | 10 10 0 |
| | Sheets „ | „ Liverpool | 10 10 0 | „ | 11 0 0 |
| | „ „ | „ London | 11 0 0 | „ | 11 10 0 |
| | Bars „ | „ Liverpool | 8 10 0 | „ | 9 0 0 |
| | „ „ | „ London | 9 0 0 | „ | 9 10 0 |
| | Scotch Pig (No.1. g.m.b.) | the Clyde | 3 4 0 | „ | 3 5 0 |
| | Rails ................ | in Wales | —— | „ | 7 0 0 |
| | Swedish—Hammered—large sizes | | —— | „ | 11 15 0 |
| | „ „ Indian assortments | | 12 15 0 | „ | 13 0 0 |
| STEEL ........ | „ „ Hammered—faggot | | 17 0 0 | „ | 17 10 0 |
| | „ „ in kegs ($\frac{1}{4}$ and $\frac{5}{8}$ in.) | | —— | „ | 16 0 0 |
| COPPER ...... Australian .. | Burra and P.C.C. ............ | | —— | „ | 100 0 0 |
| | Kapunda .................. | | 102 0 0 | „ | 105 0 0 |
| | Wallaroo .................. | | —— | „ | 100 0 0 |
| American.... | Baltimore .................. | | —— | „ | none |
| | Lake Superior ............. | | —— | „ | „ |
| | Spanish Cake................ | | —— | „ | 94 0 0 |
| | Chili and other Slab (for 96 per cent. pure Copper) ........ | | —— | „ | 90 0 0 |
| English .... | Tough Cake and Ingot and Tile | | —— | „ | 98 0 0 |
| | Best selected Ingot .......... | | —— | „ | 101 0 0 |
| | Sheets, Sheathing and Rod .... | | —— | „ | 105 0 0 |
| | Flat Bottoms................ | | —— | „ | 110 0 0 |
| | | | | Per lb. | |
| YELLOW METAL.. | Sheets .................... | | 8½*d.* | @ | 9*d.* |
| | Sheathing and Rod ........ | | 9*d.* | „ | 9¼*d.* |
| | | | | Per Cwt. | |
| TIN ......... English .. | Common Blocks and Ingots .... | | —— | @ | 112*s.* |
| | „ Bars (in barrels) ...... | | —— | „ | 113*s.* |
| | Refined .................... | | —— | „ | 117*s.* |
| Foreign .. | Straits, Fine .................. | | 113*s.* | „ | 114*s.* |
| | „ (with 3 months' prompt) | | 115*s.* | „ | 116*s.* |
| | Banca ...................... | | 114*s.* | „ | 116*s.* |
| | | | | Per Box. | |
| TIN PLATES at Liverpool 6*d.* Less | Charcoal IC, best............. | | 29*s.* 0*d.* | @ | 30*s.* 0*d.* |
| | „ IX „ ............ | | 35*s.* 0*d.* | „ | 36*s.* 0*d.* |
| | Coke IC ................ | | 23*s.* 6*d.* | „ | 25*s.* 6*d.* |
| | „ IX ................ | | 29*s.* 6*d.* | „ | 31*s.* 6*d.* |
| | | | | Per Ton. | |
| LEAD........ English .. | Sheet ...................... | | —— | @ | £21 0 0 |
| | Pig—W.B. .................. | | —— | „ | 21 10 0 |
| | „ Other good brands ........ | | —— | „ | 20 10 0 |
| | „ German and Spanish, soft .. | | £19 15 0 | „ | 20 0 0 |
| English .. | Red ...................... | | —— | „ | 21 10 0 |
| | Shot ...................... | | —— | „ | 23 0 0 |
| | Dry White.................. | | —— | „ | 26 0 0 |
| SPELTER ...... | (Silesian) in Cakes ............ | | —— | „ | 18 5 0 |
| ZINC .......... | (Sheet) No. 9 and upwards .... | | —— | „ | 24 0 0 |
| | | | | Per Bottle. | |
| QUICKSILVER | (in bottles containing 75lbs. each) | | —— | @ | 7 0 0 |
| | | | | Per Ton. | |
| GULUS OF ANTIMONY, | French Star ...... | | —— | @ | 38 0 0 |

# Tabular Abstract of Mining Accounts for the Month.

| Date of Account. | Name of Mine, and Number of Shares. | Balances. Debit. | Balances. Credit. | Calls. Per Share. | Calls. Total. | Dividends. Per Share. | Dividends. Total. |
|---|---|---|---|---|---|---|---|
| | | £ s. d. | £ s. d. | £ s. d | £ s. d. | £ s. d. | £ s. d. |
| | CORNISH & DEVON MINES. | | | | | | |
| Oct. 20 | Fowey Consols (940)............ | — | 970 15 8 | — | — | — | — |
| „ 22 | Chiverton (3,000) ............... | — | 2,896 15 6 | — | — | — | — |
| „ 22 | Wheal Falmouth & Sperries (2,000) ............................ | 2,195 6 1 | — | 1 0 0 | 2,000 0 0 | — | — |
| „ 22 | Wendron Consols (1,024)...... | 563 7 8 | — | 0 10 0 | 512 0 0 | — | — |
| „ 23 | Caradon United (6,000) ...... | — | 606 0 0 | — | — | — | — |
| „ 26 | East Pool (128) .................. | — | 670 16 4 | — | — | 5 0 0 | 640 0 0 |
| „ 27 | Wheal Kitty (St. Agnes) (4,295) ............................ | — | 1,879 5 6 | — | — | 0 5 0 | 1,073 15 0 |
| „ 27 | Hingston Down (6,000)......... | — | 122 10 0 | 0 1 0 | 300 0 0 | — | — |
| „ 27 | Wheal Emma (4,000)............ | — | 133 4 7 | — | — | — | — |
| „ 27 | East Carn Brea (6,000)......... | — | 267 2 2 | — | — | — | — |
| „ 27 | Wheal Trannack (512) ......... | 1 18 8 | — | 0 3 6 | 89 12 0 | — | — |
| „ 28 | Crowan Consols (6,000) ...... | — | 254 16 7 | — | — | — | — |
| „ 28 | North Basset (6,000)............ | 268 3 2 | — | 0 3 0 | 900 0 0 | — | — |
| „ 28 | Okel Tor (4,096).................. | 1,084 13 0 | — | 0 5 0 | 1,024 0 0 | — | — |
| „ 28 | Wheal Ludcott and Wrey (4,800) ............................ | 2,085 18 11 | — | 0 10 0 | 2,400 0 0 | — | — |
| „ 28 | North Grylls (        ) ........... | 46 6 4 | — | 0 2 0 | — | — | — |
| „ 29 | Kelly Bray (5,000)............... | 14 0 0 | — | — | — | — | — |
| „ 29 | Lady Bertha (6,000) ............ | 351 10 3 | — | 0 1 6 | 450 0 0 | — | — |
| „ 29 | North Jane (2,000) ............ | 564 7 3 | — | 0 6 0 | 600 0 0 | — | — |
| „ 30 | Rosewarne Consols (4,026) ... | 925 7 3 | — | 0 10 0 | 2,013 0 0 | — | — |
| „ 30 | Leeds and St. Aubyn (1,019) | — | 297 8 10 | — | — | — | — |
| Nov. 2 | South Frances (496) ............ | — | 1,201 0 0 | — | — | 1 0 0 | 496 0 0 |
| „ 2 | St. Day United (4,000) ......... | — | 428 16 0 | — | — | — | — |
| „ 3 | Wheal Jane (512) ..... ......... | — | 506 15 6 | — | — | — | — |
| „ 4 | East Treskerby (1,024) ......... | 467 16 7 | — | 1 0 0 | 1,024 0 0 | — | — |
| „ 4 | Stray Park (920)......... ........ | — | — | 0 18 0 | 828 0 0 | — | — |
| „ 5 | Tywarnhaile (6,000) ............ | 602 17 5 | — | — | — | — | — |
| „ 5 | St. Ives Wheal Allen (1,024) | 565 5 0 | — | 0 11 0 | 563 4 0 | — | — |
| „ 5 | East Jane (6,145) ........... ... | 982 5 4 | — | 0 3 6 | 1,075 7 6 | — | — |
| „ 5 | South Caradon Wheal Hooper (4096) ........................... | 150 4 8 | — | 0 2 0 | 409 12 0 | — | — |
| „ 6 | Calvadnack (915) ............... | — | — | 0 7 0 | 320 5 0 | — | — |
| „ 10 | Wheal Crebor (6,000) ......... | — | 300 0 0 | 0 1 6 | 450 0 0 | — | — |
| „ 10 | North Roskear (700) ............ | 1,375 15 6 | — | 2 0 0 | 1,400 0 0 | — | — |
| „ 10 | Roskearnoweth (700) ......... | — | 73 3 8 | — | — | — | — |
| „ 10 | Par Consols (6,400) ............ | — | 4,661 15 5 | — | — | — | — |
| „ 10 | Grambler & St. Aubyn (486) | 287 16 5 | — | 1 0 0 | 486 0 0 | — | — |
| „ 12 | Frank Mills (5,000) ............ | — | 1,511 9 3 | — | — | 0 1 6 | 375 0 0 |
| „ 12 | South Exmouth (5,000)......... | 2,060 10 4 | — | 0 5 0 | 1,250 0 0 | — | — |
| „ 12 | Charlotte United (6,000) ...... | — | — | 0 5 6 | 1,650 0 0 | — | — |
| „ 16 | West Damsel (256)............... | — | 535 0 0 | — | — | — | — |
| „ 17 | Wheal Buller (256) ............ | 738 2 4 | — | — | — | — | — |
| „ 17 | Wheal Par (1,024) ................ | — | — | 0 12 6 | 640 0 0 | — | — |
| „ 17 | St. Ives Consols (940) ......... | — | — | — | — | 0 10 0 | 470 0 0 |
| „ 18 | West Caradon (1,024) ......... | — | 2,303 16 5 | — | — | — | — |
| „ 18 | Holmbush (10,000)............... | 1,890 0 0 | — | — | — | — | — |
| „ 19 | Wheal Trelawny (1,040) ...... | — | 1,185 0 0 | — | — | 0 12 6 | 650 0 0 |
| „ 19 | Great Wheal Fortune (1,798) | — | 1,650 12 1 | — | — | 0 10 0 | 899 0 0 |
| „ 20 | Devon Great Consols (1,024) | — | 31,744 9 5 | — | — | 9 0 0 | 9,216 0 0 |
| | West Wheal Jane (9,017)...... | 1,508 2 9 | — | 0 3 4 | 1,502 16 8 | — | — |
| „ 20 | Wheal Owles (80) ............... | — | 2,074 12 4 | — | — | 5 0 0 | 400 0 0 |
| „ 20 | Prosper United (6,000) ......... | — | 294 19 9 | — | — | — | — |
| „ 25 | Wheal Edward (4,096) ......... | 135 5 4 | — | 0 2 6 | 512 0 0 | — | — |
| | WELSH & OTHER MINES. | | | | | | |
| Oct. 26 | Bronfloyd (5,000) ............... | — | — | — | — | 0 2 6 | 625 0 0 |
| „ 29 | Long Rake (2,000)............... | 550 0 0 | — | 0 5 0 | 500 0 0 | — | — |
| „ 29 | Dolfrwynog (10,880) ............ | — | — | 0 2 6 | 1,360 0 0 | — | — |
| „ 29 | Bryn Gwiog (500) ............... | — | 650 0 0 | — | — | — | — |
| „ 29 | Billins (400)........................ | 528 0 0 | — | 5 0 0 on new shares | 1,000 0 0 | — | — |
| „ 30 | Alderley Edge (1,200) ......... | — | 1,329 10 8 | — | — | 1 0 0 | 1,200 0 0 |
| Nov. 12 | Gwdyr Park Consols (6,068) | — | 88 17 9 | 0 0 6 | 151 14 0 | — | — |
| „ 17 | North Minera (20,000) ......... | — | 5,699 0 0 | — | — | — | — |
| | FOREIGN MINES. | | | | | | |
| Nov. 18 | West Canada (20,000) ......... | — | — | — | — | 0 3 0 | 3,000 0 0 |

# Copper Ores.

**Sampled Oct. 14, and sold at Tabb's Hotel, Redruth, Oct. 29.**

| Mines | Tons. | Purchasers. | Price. | | |
|---|---|---|---|---|---|
| Clifford Amalgamated | 75 | 5 | £3 | 5 | 6 |
| | 65 | 10 | 0 | 15 | 6 |
| | 64 | 7 | 3 | 14 | 6 |
| | 53 | 1, 10 | 0 | 17 | 6 |
| | 50 | 1 | 3 | 6 | 0 |
| | 37 | 1 | 1 | 9 | 6 |
| | 36 | 5 | 5 | 9 | 0 |
| | 28 | 1, 6 | 16 | 8 | 6 |
| | 24 | 12 | 2 | 15 | 0 |
| | 20 | 1 | 4 | 6 | 0 |
| | 16 | 5 | 0 | 7 | 6 |
| | 15 | 3 | 11 | 3 | 6 |
| South Caradon ......... | 101 | 1, 6, 7 | 6 | 9 | 0 |
| | 80 | 11 | 6 | 8 | 0 |
| | 62 | 1, 6 | 8 | 16 | 6 |
| | 55 | 1, 6 | 19 | 16 | 6 |
| | 49 | 1, 6 | 16 | 12 | 6 |
| | 42 | 13 | 9 | 5 | 0 |
| | 36 | 6 | 6 | 15 | 6 |
| | 34 | 1 | 6 | 17 | 6 |
| Great Wheal Busy ... | 88 | 3, 6 | 2 | 16 | 6 |
| | 82 | 3, 12 | 3 | 1 | 6 |
| | 66 | 2 | 2 | 6 | 6 |
| | 56 | 2 | 2 | 14 | 0 |
| | 55 | 9 | 3 | 9 | 0 |
| | 48 | 1 | 2 | 0 | 6 |
| | 23 | 6 | 2 | 13 | 6 |
| West Damsel............ | 78 | 7 | 3 | 18 | 6 |
| | 75 | 6 | 4 | 16 | 6 |
| | 74 | 10 | 2 | 19 | 0 |
| | 55 | 6 | 4 | 3 | 6 |
| West Damsel............ | 34 | 6 | £4 | 9 | 0 |
| | 29 | 7 | 4 | 16 | 0 |
| Fowey Consols ......... | 75 | 5 | 5 | 8 | 6 |
| | 72 | 1, 9 | 6 | 2 | 6 |
| | 71 | 1 | 7 | 10 | 6 |
| | 62 | 4, 6 | 6 | 19 | 6 |
| | 48 | 5 | 6 | 13 | 0 |
| Tywarnhaile ............ | 109 | 3 | 3 | 7 | 0 |
| | 78 | 3 | 3 | 19 | 6 |
| | 58 | 3 | 7 | 2 | 6 |
| | 56 | 12 | 2 | 2 | 0 |
| | 27 | 7 | 12 | 16 | 6 |
| Craddock Moor......... | 68 | 2, 9 | 8 | 0 | 6 |
| | 63 | 7 | 6 | 1 | 6 |
| | 36 | 11 | 7 | 16 | 0 |
| | 23 | 13 | 5 | 10 | 6 |
| | 21 | 7 | 3 | 11 | 0 |
| New Treleigh ......... | 58 | 2 | 2 | 19 | 0 |
| | 56 | 9 | 2 | 14 | 6 |
| | 13 | 2 | 9 | 9 | 6 |
| Great North Downs... | 76 | 6 | 4 | 19 | 6 |
| Great Brigan............ | 48 | 2 | 4 | 11 | 0 |
| | 9 | 9 | 2 | 6 | 6 |
| Falmouth & Sperries | 52 | 1, 5 | 3 | 19 | 6 |
| Boscawen ............... | 40 | 12 | 5 | 6 | 6 |
| North Grambler ...... | 20 | 7 | 6 | 2 | 6 |
| | 9 | 10 | 1 | 11 | 6 |
| Wheal Towan ......... | 20 | 12 | 1 | 17 | 6 |
| East Treskerby......... | 8 | 3 | 5 | 9 | 6 |
| Phillips's Ore............ | 3 | 12 | 9 | 15 | 6 |
| Pembroke ............... | 2 | 12 | 3 | 9 | 6 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Clifford Amalgamated...... | 483 | £1,782 | 1 | 6 |
| South Caradon ............... | 459 | 4,481 | 15 | 0 |
| Great Wheal Busy ......... | 418 | 1,153 | 17 | 6 |
| West Damsel ................. | 345 | 1,406 | 9 | 0 |
| Fowey Consols ............... | 328 | 2,133 | 16 | 0 |
| Tywarnhaile .................. | 328 | 1,552 | 6 | 6 |
| Craddock Moor ............... | 211 | 1,410 | 17 | 0 |
| New Treleigh .................. | 127 | 446 | 17 | 6 |
| Great North Downs ......... | 76 | 378 | 2 | 0 |
| Great Brigan .................. | 57 | £239 | 6 | 6 |
| Falmouth and Sperries ...... | 52 | 206 | 14 | 0 |
| Boscawen ........................ | 40 | 213 | 0 | 0 |
| North Grambler ............... | 29 | 136 | 13 | 6 |
| Wheal Towan .................. | 20 | 37 | 10 | 0 |
| East Treskerby.................. | 8 | 43 | 16 | 0 |
| Phillip's Ore ...................... | 3 | 29 | 6 | 6 |
| Pembroke........................... | 2 | 6 | 19 | 0 |

## EACH COMPANY'S PURCHASE.

| | | Tons. | Amount. | | |
|---|---|---|---|---|---|
| 1 | Vivian and Sons ......... | 479½ | £3,191 | 0 | 3 |
| 2 | Freeman and Co.......... | 275 | 1,090 | 3 | 6 |
| 3 | Grenfell and Sons ...... | 353 | 1,550 | 5 | 0 |
| 4 | Crown Copper Co. ...... | 31 | 216 | 4 | 6 |
| 5 | Sims, Willyams & Co. | 276 | 1,277 | 5 | 0 |
| 6 | Williams, Foster & Co. | 504¾ | 3,440 | 0 | 6 |
| 7 | Mason and Elkington... | 335¾ | 1,826 | 19 | 0 |
| 8 | Bankart and Sons ...... | — | — | | |
| 9 | Copper Miners' Co. ...... | 190 | £856 | 12 | 6 |
| 10 | Charles Lambert ......... | 174½ | 306 | 0 | 9 |
| 11 | Newton, Keates & Co. ... | 116 | 792 | 16 | 0 |
| 12 | Sweetland, Tuttle & Co. | 186 | 596 | 9 | 0 |
| 13 | Penclawdd Copper Co. | 65 | 515 | 11 | 6 |
| | Total .............. | 2,986 | £15,659 | 7 | 6 |

Average Produce, 6¾.
Quantity of Fine Copper, 190 tons 5 cwts.

Average Standard ..................£125 9 0
Average Price per ton ............ 5 5 0

# Copper Ores.

**Sampled Oct. 21, and sold at Tabb's Hotel, Redruth, Nov. 5.**

| Mines. | Tons. | Purchasers. | Price. | Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|---|---|---|---|
| Clifford Amalgamated | 101 | 3 | £6 8 0 | Tolcarne | 46 | 5 | £5 14 0 |
| | 95 | 3, 12 | 4 16 0 | | 38 | 1 | 4 15 6 |
| | 94 | 3, 6 | 4 18 6 | | 32 | 10 | 2 8 6 |
| | 88 | 3 | 5 0 0 | | 27 | 10 | 3 1 0 |
| | 85 | 3 | 6 10 6 | North Roskear (Pend.) | 52 | 1 | 5 4 6 |
| | 80 | 3 | 4 16 0 | (Enys) | 45 | 3, 7 | 11 7 6 |
| | 57 | 2 | 2 19 6 | | 41 | 3 | 7 15 6 |
| West Seton | 84 | 3 | 6 0 0 | | 40 | 3 | 2 9 0 |
| | 66 | 8 | 4 15 6 | Wheal Basset | 82 | 5 | 6 0 0 |
| | 65 | 3 | 5 2 6 | | 60 | 5 | 5 6 6 |
| | 63 | 3 | 8 16 6 | | 23 | 5 | 11 5 0 |
| | 55 | 3 | 7 2 6 | South Frances | 49 | 1, 7 | 6 3 6 |
| | 49 | 12 | 2 17 0 | | 45 | 1 | 5 1 0 |
| | 46 | 3 | 7 4 6 | | 44 | 6 | 7 2 0 |
| Wheal Seton | 94 | 6, 7 | 4 12 6 | | 21 | 7 | 8 2 6 |
| (Pendarves) | 71 | 2 | 6 18 0 | | 4 | 5 | 4 3 0 |
| | 68 | 6 | 6 10 6 | Wheal Grenville | 49 | 1, 5 | 13 18 6 |
| | 64 | 6 | 5 18 6 | | 42 | 1 | 7 12 6 |
| | 19 | 7 | 1 12 0 | | 28 | 1 | 6 10 0 |
| | 14 | 3 | 16 10 0 | | 23 | 1 | 9 9 6 |
| | 6 | 5 | 2 9 0 | East Basset | 33 | 1, 5 | 7 18 6 |
| East Pool | 105 | 9 | 3 19 0 | | 29 | 7 | 10 0 0 |
| | 74 | 8 | 3 13 0 | | 20 | 1, 7 | 4 14 0 |
| | 59 | 9 | 3 18 6 | | 19 | 7 | 9 14 6 |
| South Tolgus | 59 | 7 | 5 5 6 | | 11 | 12 | 3 2 6 |
| | 58 | 6 | 6 4 0 | Tresavean | 45 | 10 | 2 11 6 |
| | 46 | 9 | 7 0 6 | | 24 | 10 | 1 13 0 |
| | 44 | 5 | 6 15 6 | East Grenville | 50 | 12 | 3 1 6 |
| | 20 | 9 | 2 0 6 | | 12 | 1 | 3 0 0 |
| Tolcarne | 58 | 1 | 3 6 6 | West Stray Park | 55 | 9 | 5 16 0 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| Clifford Amalgamated | 600 | £3,113 11 0 | Wheal Basset | 165 | £1,070 5 0 |
| West Seton | 428 | 2,572 2 6 | South Frances | 163 | 1,029 9 0 |
| Wheal Seton | 336 | 2,023 13 0 | Wheal Grenville | 142 | 1,402 10 0 |
| East Pool | 238 | 916 8 0 | East Basset | 112 | 864 13 6 |
| South Tolgus | 227 | 1,332 11 6 | Tresavean | 69 | 155 9 6 |
| Tolcarne | 201 | 769 9 0 | East Grenville | 62 | 189 15 0 |
| North Roskear | 179 | 1,205 11 6 | West Stray Park | 55 | 319 0 0 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Vivian and Sons | 374½ | £2,304 17 3 | 9 Copper Miners' Co. | 285 | £1,328 19 6 |
| 2 Freeman and Co. | 128 | 659 9 6 | 10 Charles Lambert | 128 | 315 8 9 |
| 3 Grenfell and Sons | 879 | 5,505 10 9 | 11 Newton, Keates & Co. | — | — |
| 4 Crown Copper Co. | — | — | 12 Sweetland, Tuttle & Co. | 157½ | 555 15 6 |
| 5 Sims, Willyams & Co. | 306 | 2,133 15 6 | 13 Penclawdd Copper Co. | — | — |
| 6 Williams, Foster & Co. | 328 | 1,943 15 0 | | | |
| 7 Mason and Elkington | 251 | 1,658 12 6 | Total | 2,977 | £16,991 9 0 |
| 8 Bankart and Sons | 140 | 585 5 0 | | | |

Average Produce, 6⅝.
Quantity of Fine Copper, 196 tons 13 cwts.

Average Standard ..................£128 1 0
Average Price per ton ............ 5 14

# Copper Ores.

**Sampled Oct. 28, and sold at Tabb's Hotel, Bedruth, Nov. 12.**

| Mines. | Tons. | Purchasers. | Price. | Mines. | Tons. | Purchasers. | Price. |
|---|---|---|---|---|---|---|---|
| West Basset | 78 | 2 | £3 19 6 | East Rosewarne | 27 | 1, 6 | £13 11 6 |
| | 68 | 7 | 8 12 6 | | 14 | 3 | 2 16 6 |
| | 67 | 7 | 5 14 0 | Botallack | 58 | 1 | 9 10 6 |
| | 58 | 7 | 5 16 0 | | 36 | 1 | 4 13 6 |
| | 43 | 9 | 8 4 0 | | 27 | 6 | 8 13 6 |
| | 40 | 9 | 7 4 6 | Wheal Anna | 109 | 2, 5 | 5 2 6 |
| | 34 | 2 | 7 6 0 | Copper Hill | 42 | 1 | 8 6 6 |
| East Carn Brea | 54 | 3 | 5 8 6 | | 33 | 12 | 2 10 0 |
| | 53 | 7 | 5 2 0 | | 31 | 10 | 1 7 6 |
| | 50 | 7 | 4 14 6 | Tolvadden | 52 | 5 | 4 4 0 |
| | 49 | 3 | 5 13 0 | | 36 | 2 | 7 7 6 |
| | 43 | 3 | 6 10 6 | | 10 | 1 | 14 0 0 |
| | 32 | 10 | 4 0 6 | Alfred Consols | 64 | 3 | 1 19 0 |
| | 31 | 10 | 3 13 0 | | 16 | 3 | 3 18 0 |
| | 29 | 10 | 3 7 0 | Wheal Buller | 40 | 2, 3, 6, 9 | 2 18 0 |
| | 28 | 3 | 6 3 0 | | 12 | 3 | 10 2 6 |
| Levant | 74 | 1, 6 | 5 13 6 | Bampfylde | 50 | 1, 5, 6 | 14 1 0 |
| | 70 | 6 | 7 1 6 | Molland | 40 | 8 | 4 18 6 |
| | 63 | 1, 6 | 1 1 0 | | 10 | 1, 5, 6 | 10 5 6 |
| | 45 | 5 | 4 14 6 | North Basset | 26 | 5 | 3 19 0 |
| | 2 | 1 | 19 2 6 | | 22 | 9 | 4 6 6 |
| Prosper United | 87 | 6 | 5 7 6 | South Crenver | 24 | 8 | 3 3 6 |
| | 69 | 13 | 3 13 6 | | 16 | 2 | 8 10 6 |
| | 59 | 1 | 2 13 0 | Champion's Ore | 24 | 1, 5 | 4 14 0 |
| | 19 | 5 | 5 9 0 | | 10 | 5 | 2 18 0 |
| Par Consols | 64 | 2 | 7 5 6 | South Carn Brea | 24 | 12 | 3 14 0 |
| | 62 | 5 | 6 12 0 | | 1 | 8 | 45 13 6 |
| | 55 | 5 | 1 10 6 | Emily Henrietta | 24 | 7 | 6 17 0 |
| Wheal Margery | 64 | 12 | 1 18 6 | East Alfred Consols | 23 | 12 | 5 3 6 |
| | 59 | 6 | 2 12 6 | West Wheal Trevelyan | 17 | 5, 12 | 4 18 0 |
| | 53 | 6 | 7 8 6 | Great Wheal Alfred | 11 | 7 | 4 5 0 |
| East Rosewarne | 46 | 3 | 7 8 6 | Wheal Agar | 11 | 2 | 6 6 6 |
| | 38 | 1, 3 | 8 4 6 | | | | |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| West Basset | 388 | £2,504 13 0 | Wheal Buller | 52 | £237 10 0 |
| East Carn Brea | 369 | 1,869 9 0 | Bampfylde | 50 | 702 10 0 |
| Levant | 254 | 1,232 4 6 | Molland | 50 | 299 15 0 |
| Prosper United | 234 | 981 2 0 | North Basset | 48 | 197 17 0 |
| Par Consols | 181 | 958 13 6 | South Crenver | 40 | 212 12 0 |
| Wheal Margery | 176 | 671 12 0 | Champion's Ore | 34 | 141 16 0 |
| East Rosewarne | 125 | 1,060 3 6 | South Carn Brea | 25 | 134 9 6 |
| Botallack | 121 | 954 19 6 | Emily Henrietta | 24 | 164 8 0 |
| Wheal Anna | 109 | 558 12 6 | East Alfred Consols | 23 | 119 0 6 |
| Copper Hill | 106 | 474 15 6 | West Wheal Trevelyan | 17 | 83 6 0 |
| Tolvadden | 98 | 623 18 0 | Great Wheal Alfred | 11 | 46 15 0 |
| Alfred Consols | 80 | 187 4 0 | Wheal Agar | 11 | 69 11 6 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. | | Tons. | Amount. |
|---|---|---|---|---|---|
| 1 Vivian and Sons | 340 | £2,312 8 1 | 9 Copper Miners' Co. | 115 | £765 15 0 |
| 2 Freeman and Co. | 303½ | 1,803 12 9 | 10 Charles Lambert | 123 | 381 14 6 |
| 3 P. Grenfell and Sons | 355 | 1,898 17 6 | 11 Newton, Keates & Co. | — | — |
| 4 Crown Copper Co. | — | — | 12 Sweetland, Tuttle & Co. | 152½ | 455 3 6 |
| 5 Sims, Willyams & Co. | 364 | 1,805 2 7 | 14 Penclawdd Copper Co. | 69 | 253 11 6 |
| 6 Williams, Foster & Co. | 408 | 2,469 4 7 | | | |
| 7 Mason and Elkington | 331 | 2,022 10 0 | Total | 2,626 | £14,486 17 6 |
| 8 Bankart and Sons | 65 | 318 17 6 | | | |

Average Produce, 6¾.
Quantity of Fine Copper, 174 tons 3 cwts.

Average Standard ................. £124 13 0
Average Price per ton ........... 5 10 6

# Copper Ores.

**Sampled Nov. 4, and sold at the Royal Hotel, Truro, Nov. 19**

| Mines. | Tons. | Purchasers. | Price. £ | s. | d. |
|---|---|---|---|---|---|
| Devon Great Consols | 141 | 1 | £4 | 5 | 6 |
| | 134 | 1 | 5 | 1 | 6 |
| | 132 | 6 | 5 | 4 | 0 |
| | 128 | 2, 12 | 4 | 8 | 6 |
| | 124 | 11 | 5 | 5 | 0 |
| | 122 | 6 | 5 | 17 | 0 |
| | 121 | 1 | 5 | 1 | 6 |
| | 120 | 6 | 5 | 12 | 0 |
| | 119 | 9 | 5 | 10 | 0 |
| | 117 | 5, 6 | 4 | 10 | 0 |
| | 116 | 5 | 4 | 17 | 6 |
| | 112 | 1, 10 | 1 | 7 | 0 |
| | 110 | 5 | 4 | 9 | 6 |
| | 108 | 1, 6 | 3 | 15 | 6 |
| | 94 | 3 | 5 | 5 | 6 |
| | 91 | 2, 3 | 6 | 6 | 6 |
| | 84 | 5 | 5 | 8 | 0 |
| | 80 | 1 | 2 | 1 | 6 |
| | 79 | 13 | 4 | 7 | 6 |
| | 57 | 3 | 13 | 0 | 6 |
| | 56 | 13 | 5 | 8 | 6 |
| | 54 | 3 | 12 | 18 | 6 |
| | 48 | 10 | 2 | 2 | 0 |
| | 26 | 8 | 4 | 17 | 0 |
| | 19 | 1 | 5 | 5 | 6 |
| | 6 | 1 | 45 | 10 | 0 |
| East Caradon | 93 | 12 | 4 | 6 | 6 |
| | 91 | 6 | 4 | 16 | 0 |
| | 88 | 8 | 4 | 4 | 6 |
| | 78 | 8, 12 | 4 | 4 | 6 |
| | 63 | 5 | 7 | 9 | 0 |
| | 46 | 5 | 7 | 17 | 0 |
| | 43 | 9 | 6 | 17 | 0 |
| Phœnix Mines | 106 | 6 | 4 | 3 | 6 |
| | 86 | 1 | 4 | 3 | 0 |
| | 77 | 8 | 3 | 4 | 6 |
| | 65 | 1, 7 | 7 | 12 | 6 |
| | 60 | 9 | 3 | 14 | 0 |
| | 51 | 9 | 2 | 4 | 6 |
| Hingston Down | 82 | 7, 8 | 2 | 7 | 6 |
| | 77 | 2 | 3 | 3 | 0 |
| | 75 | 8 | 3 | 14 | 0 |
| | 71 | 2 | 5 | 8 | 6 |
| | 64 | 8 | 3 | 9 | 0 |
| | 60 | 6, 7, 12 | 2 | 9 | 6 |
| Marke Valley | 89 | 4, 6 | £3 | 6 | 6 |
| | 85 | 8 | 3 | 1 | 6 |
| | 80 | 8 | 3 | 4 | 6 |
| | 45 | 1 | 1 | 13 | 6 |
| | 44 | 1 | 2 | 14 | 6 |
| | 43 | 5 | 1 | 7 | 0 |
| | 30 | 9 | 6 | 10 | 6 |
| New Wheal Martha | 96 | 1, 5 | 2 | 3 | 0 |
| | 94 | 1, 5 | 1 | 14 | 0 |
| | 78 | 1, 5 | 2 | 12 | 0 |
| | 65 | 1, 5 | 1 | 18 | 0 |
| | 54 | 1, 5 | 2 | 9 | 6 |
| | 27 | 1, 5 | 1 | 15 | 6 |
| East Russell | 52 | 10 | 3 | 4 | 0 |
| | 51 | 7 | 4 | 8 | 0 |
| | 48 | 12 | 3 | 9 | 6 |
| | 36 | 6 | 9 | 3 | 0 |
| | 24 | 2 | 5 | 11 | 6 |
| Wheal Edward | 61 | 6 | 3 | 13 | 0 |
| | 60 | 6 | 4 | 10 | 6 |
| | 59 | 9 | 1 | 15 | 0 |
| | 27 | 1 | 3 | 7 | 0 |
| Bedford United | 110 | 6 | 4 | 7 | 6 |
| | 93 | 6 | 3 | 15 | 6 |
| Wheal Friendship | 72 | 7 | 2 | 19 | 0 |
| | 42 | 1, 6, 9 | 9 | 11 | 6 |
| | 40 | 1, 6 | 10 | 0 | 6 |
| Holmbush | 50 | 7 | 9 | 14 | 0 |
| | 40 | 11 | 9 | 11 | 6 |
| | 32 | 6 | 3 | 11 | 6 |
| | 28 | 7 | 11 | 14 | 0 |
| Wheal Emma | 66 | 1 | 1 | 15 | 0 |
| | 31 | 12 | 5 | 13 | 6 |
| | 28 | 1 | 3 | 9 | 6 |
| Wheal Crebor | 104 | 6 | 4 | 6 | 0 |
| Lady Bertha | 80 | 3 | 2 | 0 | 6 |
| | 20 | 2 | 8 | 14 | 6 |
| New Cornish | 51 | 1, 3, 5 | 3 | 4 | 6 |
| | 49 | 3 | 3 | 9 | 6 |
| Kelly Bray | 60 | 1 | 2 | 18 | 6 |
| | 35 | 1 | 1 | 2 | 6 |
| Gunnis Lake (Clitters) | 66 | 1, 6 | 5 | 18 | 6 |
| Hawk Moor | 31 | 3, 11 | 3 | 18 | 0 |
| Fursden | 26 | 5 | 4 | 0 | 6 |
| Phillips's Ore | 3 | 1 | 8 | 5 | 6 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. £ | s. | d. |
|---|---|---|---|---|
| Devon Great Consols | 2,398 | £12,365 | 0 | 0 |
| East Caradon | 502 | 2,665 | 7 | 6 |
| Phœnix Mines | 445 | 1,878 | 17 | 6 |
| Hingston Down | 429 | 1,469 | 5 | 6 |
| Marke Valley | 416 | 1,264 | 7 | 6 |
| New Wheal Martha | 414 | 874 | 1 | 6 |
| East Russell | 211 | 1,020 | 16 | 0 |
| Wheal Edward | 207 | 687 | 17 | 0 |
| Bedford United | 203 | 832 | 6 | 6 |
| Wheal Friendship | 154 | 1,015 | 11 | 0 |
| Holmbush | 150 | £1,310 | 0 | 0 |
| Wheal Emma | 125 | 888 | 0 | 0 |
| Wheal Crebor | 104 | 447 | 4 | 0 |
| Lady Bertha | 100 | 336 | 10 | 0 |
| New Cornish | 100 | 334 | 15 | 0 |
| Kelly Bray | 95 | 214 | 17 | 6 |
| Gunnis Lake (Clitters) | 66 | 391 | 1 | 0 |
| Hawk Moor | 31 | 120 | 18 | 0 |
| Fursden | 26 | 104 | 13 | 0 |
| Phillips's Ore | 3 | 24 | 16 | 6 |

## EACH COMPANY'S PURCHASE.

| | Tons. | Amount. £ | s. | d. |
|---|---|---|---|---|
| 1 Vivian and Sons | 1,328½ | £5,080 | 9 | 0 |
| 2 Freeman and Co. | 301½ | 1,507 | 0 | 3 |
| 3 P. Grenfell and Sons | 412 | 2,671 | 11 | 3 |
| 4 Crown Copper Co. | — | —— | | |
| 5 Sims, Willyams & Co. | 775½ | 3,259 | 12 | 3 |
| 6 Williams, Foster & Co. | 3,155½ | 6,511 | 10 | 6 |
| 7 Mason and Elkington | 294½ | 1,644 | 1 | 9 |
| 8 Bankart and Sons | 575 | 2,026 | 1 | 0 |
| 9 Copper Miners' Co. | 376 | £1,717 | 11 | 6 |
| 10 Charles Lambert | 156 | 342 | 16 | 0 |
| 11 Newton, Keates & Co. | 179½ | 1,094 | 9 | 0 |
| 12 Sweetland, Tuttle & Co. | 295 | 1,242 | 8 | 6 |
| 13 Penclawdd Copper Co. | 135 | 649 | 8 | 6 |
| Total | 6,179 | £27,746 | 19 | 6 |

Average Produce, 5⅝.
Quantity of Fine Copper, 348 tons 0 cwts.

Average Standard .............. £128 11 0
Average Price per ton ............ 4 10 0

# Copper Ores.

Sampled October 7, and sold at Swansea October 27.

| Mines. | Tons. | Produce. | Purchasers. | Price. |
|---|---|---|---|---|
| Cobre | 102 | 12⅞ | 5 | £10 17 0 |
| | 98 | 12¾ | 5 | 10 15 0 |
| | 97 | 12¾ | 3 | 10 15 0 |
| | 100 | 12¾ | 3 | 10 15 6 |
| | 42 | 18⅞ | 3 | 15 18 0 |
| | 36 | 19 | 7 | 16 3 0 |
| | 7 | 14⅞ | 5 | 13 2 0 |
| (Regulus) | 20 | 28⅞ | 7 | 24 18 0 |
| Sestri | 88 | 12⅞ | 1 | 10 18 0 |
| | 86 | 13 | 1 | 10 14 0 |
| | 71 | 14 | 10 | 12 0 6 |
| | 34 | 8½ | 1 | 6 16 0 |
| | 9 | 6 | 2 | 4 15 6 |
| Fortune Copper | 71 | 15½ | 7 | 12 12 0 |
| | 70 | 15⅝ | 7 | 13 4 0 |
| | 7 | 23½ | 7 | 19 19 0 |
| Knockmahon | 101 | 13⅝ | 3 | 12 13 6 |
| Knockmahon | 100 | 13⅞ | 1 | £12 4 0 |
| Berehaven | 112 | 10⅝ | 13 | 8 19 6 |
| Copper Slag | 50 | 4¼ | 5 | 3 0 0 |
| | 37 | 4¼ | 5 | 2 16 0 |
| | 20 | 4¼ | 5 | 3 0 0 |
| Victor Emmanuel | 82 | 7½ | 7 | 6 6 0 |
| Casali | 9 | 14¼ | 7 | 13 3 0 |
| Ballycummisk | 7 | 21⅝ | 7 | 18 9 6 |
| | 19 | 14½ | 2 | 12 11 6 |
| | 55 | 4⅝ | 2 | 3 13 6 |
| Connorree Ore | 50 | 3⅛ | 6 | 2 15 0 |
| West Australia | 35 | 17 | 10 | 14 2 6 |
| Geilereath | 41 | 24⅝ | 2 | 22 1 0 |
| | 12 | 24¾ | 5, 10 | 22 2 6 |
| Gwalla | 3 | 39 | 5 | 34 2 0 |
| Regulus | 1 | 45½ | 10 | 41 10 6 |
| Victoria Slag | 7 | 6⅝ | 5 | 4 0 0 |

TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. |
|---|---|---|
| Cobre | 502 | £6,119 7 0 |
| Sestri | 288 | 3,007 7 0 |
| Fortune Copper | 148 | 1,958 5 0 |
| Knockmahon | 201 | 2,500 3 6 |
| Berehaven | 112 | 1,005 4 0 |
| Copper Slag | 107 | 313 12 0 |
| Victor Emmanuel | 82 | 516 12 0 |
| Casali | 9 | 118 7 0 |
| Ballycummisk | 81 | £570 7 6 |
| Connorree Ore | 50 | 137 10 0 |
| West Australia | 35 | 494 7 6 |
| Gellereath | 53 | 1,169 11 0 |
| Gwalla | 3 | 102 6 0 |
| Regulus | 1 | 41 10 6 |
| Victoria Slag | 7 | 28 0 0 |

EACH COMPANY'S PURCHASE.

| | Tons. | Amount. |
|---|---|---|
| 1 Copper Miners' Co. | 308 | £3,330 12 0 |
| 2 Freeman and Co. | 124 | 1,388 1 6 |
| 3 P. Grenfell and Sons | 340 | 4,068 4 6 |
| 4 Crown Copper Co. | — | —— |
| 5 Sims, Willyams, Nevill & Co. | 330 | 2,828 11 0 |
| 6 Vivians and Sons | 50 | 137 10 0 |
| 7 Williams, Foster & Co. | 302 | 3,800 18 6 |
| 8 British and For. Copper Co. | — | —— |
| 9 Mason and Elkington | — | —— |
| 10 Bankart and Sons | 113 | £1,523 8 6 |
| 11 Charles Lambert | — | —— |
| 12 Ravenhead Copper Co. | — | —— |
| 13 Sweetland, Tuttle & Co. | 112 | 1,005 4 0 |
| 14 Jennings & Co. | — | —— |
| 15 Penclawdd Copper Co. | — | —— |
| Total | 1,679 | £18,082 10 0 |

# Sundry Copper Ore Sales.

| Dates. | Mines. | Tons. c. q. | Price per ton. £ s. d. | Purchasers. | Amount of Money. £ s. d. |
|---|---|---|---|---|---|
| Oct. 7. | Great Laxey | 23 0 0 | 2 17 0 | Par Smelting Co. | 65 11 0 |
| „ 28. | „ | 29 0 0 | 5 8 0 | St. Helen's Co. | 156 12 0 |
| Nov. 3. | West Canada Mining Co. | 48 0 0 | 18 5 0 | Sims, Willyams & Co. | |
| | „ „ | 48 0 0 | 18 2 0 | ditto | |
| | „ „ | 56 0 0 | 17 14 0 | ditto | 5,729 4 0 |
| | „ „ | 56 0 0 | 18 0 0 | ditto | |
| | „ „ | 56 0 0 | 17 16 0 | ditto | |
| | „ „ | 56 0 0 | 17 13 0 | ditto | |
| | Okel Tor | 102 1 2 | 4 0 6 | — | 468 2 11 |
| | „ „ | 27 13 0 | 2 1 6 | — | |
| „ 17. | Parys (copper ore) | 170 0 0 | 5 14 0 | C. Lambert | |
| | „ | 170 0 0 | 5 14 0 | Mona Co. | |
| | „ | 44 10 0 | 2 8 6 | St. Helen's Co. | 2,968 13 6 |
| | „ | 44 10 0 | 2 8 6 | Mona Co. | |
| | „ (copper precipitate) | 60 0 0 | 9 12 0 | ditto | |
| | „ „ | 34 0 0 | 7 0 6 | ditto | |

# Copper Ores.

**Sampled Oct. 28, and sold at Swansea, Nov. 17.**

| Mines. | Tons. | Produce. | Purchasers. | Price. | | |
|---|---|---|---|---|---|---|
| Cobre | 102 | 12⅜ | 2, 7 | £10 | 16 | 0 |
| | 101 | 12½ | 5 | 10 | 19 | 6 |
| | 88 | 12½ | 7 | 10 | 18 | 0 |
| | 100 | 12½ | 6 | 10 | 16 | 0 |
| | 98 | 12⅝ | 3 | 10 | 17 | 6 |
| | 60 | 27⅞ | 9 | 20 | 7 | 6 |
| | 53 | 23 | 7 | 20 | 8 | 6 |
| | 6 | 18 | 10 | 16 | 0 | 6 |
| (Regulus) | 36 | 29¼ | 5 | 25 | 5 | 6 |
| | 33 | 28¾ | 2 | 25 | 6 | 0 |
| Berehaven | 100 | 10⅜ | 3, 6 | 8 | 17 | 0 |
| | 44 | 10½ | 2, 14 | 8 | 17 | 6 |
| Berehaven | 101 | 9⅞ | 3 | £8 | 14 | 6 |
| Cape Copper | 19 | 30 | 7, 10 | 27 | 6 | 0 |
| | 2 | 31 | 7 | 28 | 4 | 0 |
| | 9 | 20½ | 9, 14 | 48 | 12 | 0 |
| | 4 | 25 | 7 | 22 | 12 | 6 |
| | 1 | 32¾ | 14 | 29 | 12 | 0 |
| | 1 | 23 | 9 | 20 | 17 | 0 |
| | 2 | 28¼ | 10 | 25 | 17 | 6 |
| Gourock | 17 | 4⅜ | 6 | 3 | 8 | 0 |
| | 4 | 13½ | 6 | 11 | 19 | 0 |
| Oxide of Copper | 2 | 12⅝ | 10 | 10 | 1 | 6 |
| Burnt Ore | 118 | 3½ | 7, 10 | 2 | 10 | 6 |

## TOTAL PRODUCE AND VALUE.

| | Tons. | Amount. | | |
|---|---|---|---|---|
| Cobre | 677 | £9,461 | 0 | 0 |
| Berehaven | 245 | 2,156 | 14 | 6 |
| Cape Copper | 38 | 935 | 4 | 0 |
| Gourock | 21 | £105 | 12 | 0 |
| Oxide of Copper | 2 | 20 | 3 | 0 |
| Burnt Ore | 118 | 297 | 19 | 0 |

## EACH COMPANY'S PURCHASE.

| | | Tons. | Amount. | | |
|---|---|---|---|---|---|
| 1 | Copper Miners' Co. | — | — | | |
| 2 | Freeman and Co. | 106 | £1,580 | 19 | 0 |
| 3 | P. Grenfell and Sons | 249 | 2,389 | 9 | 6 |
| 4 | Crown Copper Co. | — | — | | |
| 5 | Sims, Willyams, Nevill, Druce & Co. | 137 | 2,018 | 7 | 6 |
| 6 | Vivian and Sons | 171 | 1,628 | 2 | 0 |
| 7 | Williams, Foster & Co. | 266½ | 3,147 | 15 | 0 |
| 8 | British and For. Copper Co. | — | — | | |
| 9 | Mason and Elkington | 65½ | £1,327 | 1 | 0 |
| 10 | Bankart and Sons | 78½ | 576 | 7 | 6 |
| 11 | Charles Lambert | — | — | | |
| 12 | Ravenhead Copper Co. | — | — | | |
| 13 | Sweetland, Tuttle & Co. | — | — | | |
| 14 | Jennings & Co. | 27½ | 308 | 11 | 6 |
| 15 | Penclawdd Copper Co. | — | — | | |
| | Total | 1,101 | £12,976 | 12 | 6 |

# Black Tin Sales.

| Dates. | | Mines. | Tons | c. | q. | lbs. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oct. | 17. | Kitty (St. Agnes) | 18 | 13 | 1 | 23 | | — | | — | 1255 | 14 | 9 |
| ,, | 22. | Par Consols | 21 | 11 | 0 | 13 | 66 | 5 | 0 | — | 2756 | 14 | 5 |
| | | ,, | 9 | 19 | 3 | 1 | 66 | 7 | 6 | — | | | |
| | | ,, | 9 | 19 | 1 | 24 | 66 | 15 | 0 | — | | | |
| ,, | 23. | Leeds & St. Aubyn | 5 | 4 | 0 | 4 | 68 | 5 | 0 | Chyandour | 355 | 0 | 0 |
| ,, | 24. | Gurlyn | 5 | 14 | 2 | 0 | 67 | 0 | 0 | ditto | 383 | 11 | 6 |
| ,, | 26. | North Jane | 2 | 18 | 2 | 0 | | — | | — | 184 | 5 | 6 |
| | | Cornubia | 4 | 7 | 3 | 8 | 67 | 10 | 0 | — | 296 | 7 | 11 |
| ,, | 20. | New Birch Tor | 4 | 16 | 1 | 18 | | — | | Enthoven & Sons | 322 | 19 | 6 |
| ,, | 31. | Par Consols | 53 | 11 | 1 | 2 | 67 | 0 | 0 | — | 3588 | 14 | 10 |
| Nov. | 3. | East Wheal Grenville | 3 | 7 | 0 | 21 | 69 | 10 | 0 | Mellanear | 322 | 2 | 0 |
| | | ,, | 1 | 8 | 2 | 10 | 62 | 0 | 0 | ditto | | | |
| | | North Wheal Robert | 10 | 0 | 0 | 0 | 68 | 0 | 0 | Enthoven & Sons | 680 | 0 | 0 |
| ,, | 4. | Great Wheal Busy | 20 | 17 | 3 | 21 | | — | | — | 1247 | 11 | 5 |
| ,, | 7. | ,, | 3 | 13 | 0 | 18 | | — | | ditto | 248 | 11 | 10 |
| ,, | 10. | East Wheal Lovell | 6 | 15 | 1 | 12 | 67 | 0 | 0 | Treriffe | 586 | 3 | 4 |
| | | ,, | 2 | 14 | 2 | 26 | 48 | 10 | 0 | ditto | | | |
| | | Great Wh. Vor United | 32 | 8 | 1 | 21 | | — | | — | 2251 | 7 | 2 |
| ,, | 16. | Wheal Par | 2 | 5 | 3 | 21 | 66 | 5 | 0 | Redruth Co. | 152 | 3 | 4 |
| ,, | 17. | St. Day United | 39 | 0 | 0 | 26 | | — | | — | 2243 | 3 | 3 |
| | | West Beam | 8 | 19 | 0 | 23 | 67 | 10 | 0 | Harvey & Co. | 658 | 10 | 2 |
| | | ,, | 0 | 17 | 0 | 5 | 63 | 0 | 0 | ditto | | | |

# Blende Sales.

| Date. | | Mines. | Tons. | c. | Price per ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Oct. | 10. | South Lisburne | 49 | 19 | 5 | 8 | 0 | Dillwyn & Co. | 258 | 18 | 4 |
| Nov. | 4. | Minera | 101 | 0 | 4 | 3 | 0 | Walker, Parker & Co. | 842 | 17 | 6 |
| | | ,, | 70 | 0 | 3 | 18 | 3 | ditto | | | |
| | | ,, | 21 | 0 | 2 | 2 | 6 | ditto | | | |
| | | ,, | 23 | 0 | 4 | 11 | 6 | ditto | | | |

# Lead Ore Sales.

| Dates. | | Mines. | Tons. | Price per Ton. £ | s. | d. | Purchasers. | Amount of Money. £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|
| Oct. | 26. | East Logylas | 40 | 13 | 3 | 6 | Panther Co. | 527 | 0 | 0 |
| | | Glogfach | 60 | 16 | 1 | 6 | ditto | 964 | 10 | 0 |
| | | Cwmystwith | 60 | 12 | 16 | 6 | ditto | 1,536 | 0 | 0 |
| | | ,, | 60 | 12 | 15 | 6 | ditto | | | |
| ,, | 28. | Isle of Man Mining Co. | 100 | 20 | 0 | 6 | ditto | 2,002 | 10 | 0 |
| ,, | 29. | Maesysafn | 100 | 13 | 3 | 6 | A. Eyton | 1,317 | 10 | 0 |
| | | Hendre Ucha | 8 | 13 | 1 | 0 | ditto | 104 | 8 | 0 |
| | | Bryngwyn | 14 | 13 | 15 | 6 | Walker, Parker & Co. | 278 | 10 | 0 |
| | | ,, | 6 | 14 | 5 | 6 | A. Eyton | | | |
| | | Maudlin | 7 | 12 | 18 | 0 | Newton, Keates & Co. | 90 | 6 | 0 |
| | | East Pant Du | 6 | 13 | 0 | 0 | ditto | 78 | 0 | 0 |
| | | Summer Hill | 7 | 13 | 10 | 6 | ditto | 111 | 9 | 6 |
| | | ,, | 2 | 8 | 8 | 0 | ditto | | | |
| | | North Henblas | 12 | 12 | 11 | 0 | Walker, Parker & Co. | 150 | 12 | 0 |
| | | Trelogan | 4¼ | 12 | 10 | 6 | Newton, Keates & Co. | 85 | 12 | 3 |
| | | ,, | 2¼ | 11 | 14 | 0 | Walker, Parker & Co. | | | |
| | | Dyliffe | 36 | 13 | 11 | 0 | ditto | 487 | 16 | 0 |
| | | Dyfngwm | 17 | 13 | 3 | 6 | Newton, Keates & Co. | 223 | 19 | 6 |
| | | Roman Gravels | 20 | 12 | 18 | 0 | ditto | 258 | 0 | 0 |
| Nov. | 4. | Great Laxey | 100 | 19 | 19 | 0 | Sims, Willyams & Co. | 1,995 | 0 | 0 |
| | | Wheal Mary Ann | 50 | 25 | 12 | 6 | Stock & Co. | 1,281 | 5 | 0 |
| | | Wheal Frank Mills | 50 | 15 | 5 | 6 | ditto | 1,891 | 17 | 6 |
| | | ,, | 95 | 11 | 17 | 6 | Treffry's Trustees | | | |
| | | South Exmouth | 50 | 10 | 12 | 6 | R. Michell & Son | 531 | 5 | 0 |
| ,, | 6. | Minera | 50 | 13 | 11 | 0 | Walker, Parker & Co. | 7,192 | 6 | 0 |
| | | ,, | 50 | 13 | 11 | 0 | Sims, Willyams & Co. | | | |
| | | ,, | 100 | 13 | 13 | 0 | ditto | | | |
| | | ,, | 87 | 13 | 13 | 0 | ditto | | | |
| | | ,, | 100 | 13 | 12 | 0 | ditto | | | |
| | | ,, | 23 | 13 | 11 | 0 | Walker, Parker & Co. | | | |
| | | ,, | 22 | 13 | 11 | 0 | Sims, Willyams & Co. | | | |
| | | ,, | 22 | 13 | 11 | 0 | Brymbo Co. | | | |
| | | ,, | 67 | 13 | 14 | 0 | Sims, Willyams & Co. | | | |
| | | ,, | 9 | 11 | 0 | 0 | ditto | | | |
| ,, | 9. | Frongoch | 130 | 12 | 18 | 6 | Newton, Keates & Co. | 1,680 | 5 | 0 |
| | | East Darren | 77 | 16 | 7 | 6 | ditto | 1,260 | 17 | 6 |
| | | Cwm Erfin | 60 | 16 | 10 | 6 | ditto | 991 | 10 | 0 |
| ,, | 12. | Talargoch (Maesyrerwddu) | 40 | 14 | 3 | 6 | Walker, Parker & Co. | 567 | 0 | 0 |
| | | ,, (Coetia Llys) | 153 | 15 | 6 | 6 | ditto | 2,344 | 14 | 6 |
| | | Deep Level | 15 | 13 | 13 | 6 | ditto | 205 | 2 | 6 |
| | | Brynford Hall | 3½ | 13 | 8 | 6 | A. Eyton | 46 | 19 | 9 |
| | | Pwllclar | 5¼ | 12 | 17 | 6 | Walker, Parker & Co. | 70 | 16 | 8 |
| | | Rhosesmor | 6 | 13 | 1 | 6 | A. Eyton | 78 | 9 | 0 |
| | | Parry's | 27 | 13 | 18 | 6 | Walker, Parker & Co. | 375 | 19 | 6 |
| | | Bryn Gwiog | 10 | 13 | 13 | 0 | A. Eyton | 136 | 10 | 0 |
| | | Long Rake | 18½ | 13 | 12 | 6 | ditto | 252 | 1 | 3 |
| | | Speedwell | 11 | 13 | 5 | 6 | Walker, Parker & Co. | 146 | 0 | 6 |
| | | Chware Las | 5 | 14 | 9 | 0 | ditto | 72 | 5 | 0 |
| | | Fron Hall | 9½ | 13 | 19 | 0 | A. Eyton | 145 | 13 | 9 |
| | | ,, | 1¼ | 8 | 15 | 6 | Walker, Parker & Co. | | | |
| | | Llangynog United | 26 | 13 | 8 | 6 | ditto | 349 | 1 | 0 |
| | | Llanerchyraur | 26½ | 13 | 13 | 6 | ditto | 362 | 7 | 9 |
| | | Roman Gravels | 20 | 13 | 5 | 0 | Newton, Keates & Co. | 265 | 0 | 0 |
| ,, | 13. | Wheal Hope | 30 | 18 | 6 | 0 | R. Michell & Son | 549 | 0 | 0 |
| | | Cargoll | 75 | 16 | 3 | 6 | Walker, Parker & Co. | 1,213 | 2 | 6 |
| ,, | 14. | Treweatha | 28 | 22 | 11 | 0 | Stock & Co. | 631 | 8 | 0 |
| ,, | 17. | Bronfloyd | 50 | 14 | 1 | 0 | A. Eyton | 702 | 10 | 0 |
| ,, | 23. | Dyliffe | 46 | 13 | 16 | 6 | Walker, Parker & Co. | 1,175 | 19 | 0 |
| | | ,, | 40 | 14 | 1 | 6 | A. Eyton | | | |
| ,, | 25. | Isle of Man Mining Co. | 100 | 19 | 13 | 6 | Treffry's Trustees | 1,967 | 10 | 0 |
| ,, | 26. | Maesysafn | 65 | 13 | 9 | 6 | Walker, Parker & Co. | 875 | 17 | 6 |
| | | Mount Pleasant | 10 | 13 | 10 | 6 | Newton, Keates & Co. | 135 | 5 | 0 |
| | | Hendre Ucha | 7 | 13 | 15 | 6 | Walker, Parker & Co. | 96 | 8 | 6 |
| | | Bryngwyn | 15 | 14 | 2 | 6 | A. Eyton | 284 | 10 | 0 |
| | | ,, | 5 | 14 | 10 | 6 | ditto | | | |

2'0 K5